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EXPLANATORY INFORMATION FOR NEWS CONFERENCE ON SATELLITE COMMUNICATIONS

Nippon Telegraph and Telephone Public Corp.
Electric Communications Research Center

Translation of presentation for the Japanese press article on communications satellite, Nippon Telegraph and Telephone Public Corp., Electric Communications Research Center, Tokyo (Japan), June 1982, pp. 1-39

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16. Abstract

The Electric Communications Research Center of Japan has succeeded in developing the CS-2 communications satellite which has features not used before in the world for communications satellites, such as frequencies of the 30/20GHz band, demand assign time division multiple access (DA-TDMA), improved ship-to-satellite communications methods, and new multibeam satellite communications methods. Research is continuing towards the production of larger, more economical communication systems via satellite which have greater efficiency and capacity.

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EXPLANATORY INFORMATION FOR NEWS CONFERENCE ON SATELLITE COMMUNICATIONS

*/Title

Nippon Telegraph and Telephone Public Corp.
Electric Communications Research Center

June, 1982

Exhibition Corner	Exhibited Items
[1] CS-2 satellite communications equipment	1. Antenna 2. Group branching filter 3. Repeater
[2] Integrated digital satellite communications method	Results of experiments regarding integrated digital satellite communications (panel)
[3] Ship-to-satellite communications method	1. Small ship satellite communications equipment 2. Repeater loaded on satellite for communications (bread board model)
[4] Multibeam satellite communications method (1)	Summary of multibeam satellite communications method (panel)
[5] Multibeam satellite communications method (2)	1. TDMA equipment for multibeam 2. Repeater to be loaded on satellite for multibeam communications 3. Functional experiments of multibeam satellite communications method
[6] Multibeam satellite communications method (3)	Travelling wave tube amplifier to be loaded on 20 GHz band 10W satellite
[7] Multibeam satellite communications method (4)	Antenna to be loaded on 30/20 GHz band multibeam satellite

/1

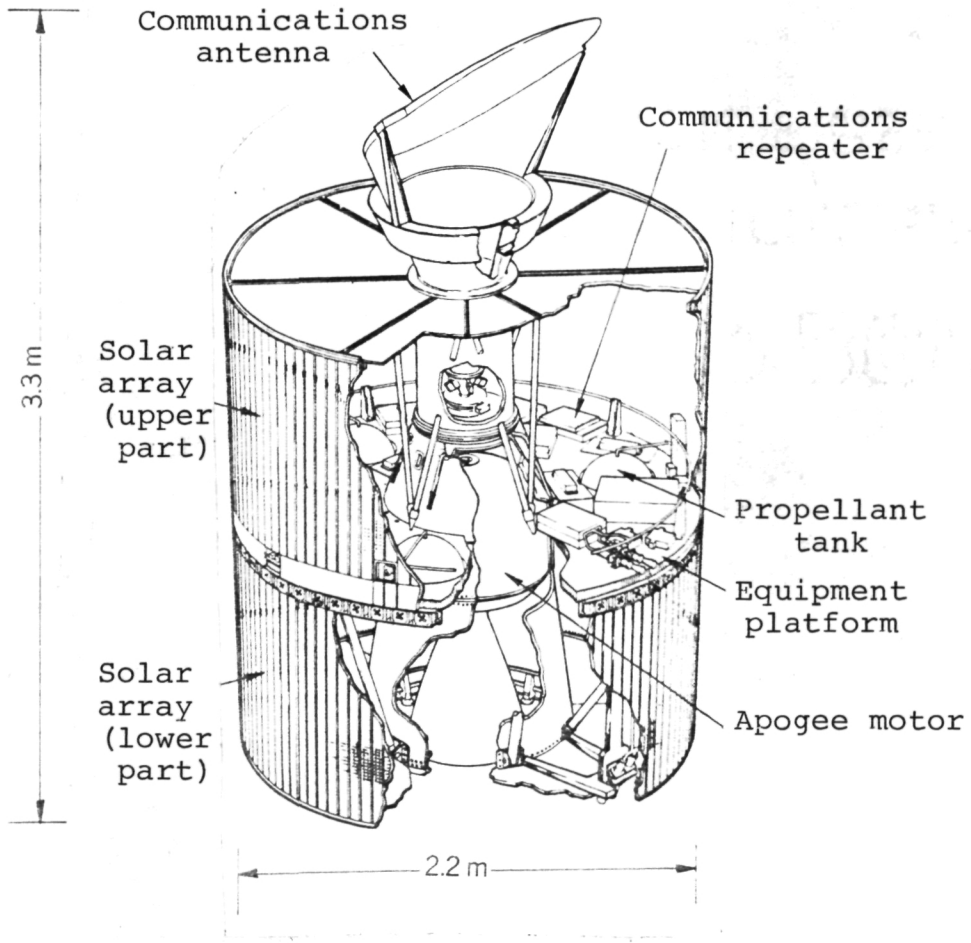
*Notes in the margin indicate pagination in the foreign text.

[1] CS-2 SATELLITE COMMUNICATIONS EQUIPMENT /2

A repeater, antenna, group branching filter, and other equipment for the communications satellite, CS-2, have been developed for the first time in Japan at the Electrical Communications Research Center.

This equipment utilizes the frequencies of the 30/20 GHz band, and is the first in the world to be actually used in a communications satellite. The comprehensive technologies of research centers, such as communications method design technique, circuit technique, highly reliable parts technology, and heat structure technique have been brought together, and Japan has succeeded in domestic production.

General Diagram of Satellite



[1]-1 CS-2 SATELLITE ANTENNA /3

This antenna was developed to be carried on the actual communications satellite CS-2 and has the following features:

1. In addition to being light in weight, the antenna was designed taking into consideration vibration upon lift-off, high vacuum in static orbit, and severe heat conditions. Light, but strong carbon fiber (CFRP) was used as the main material.

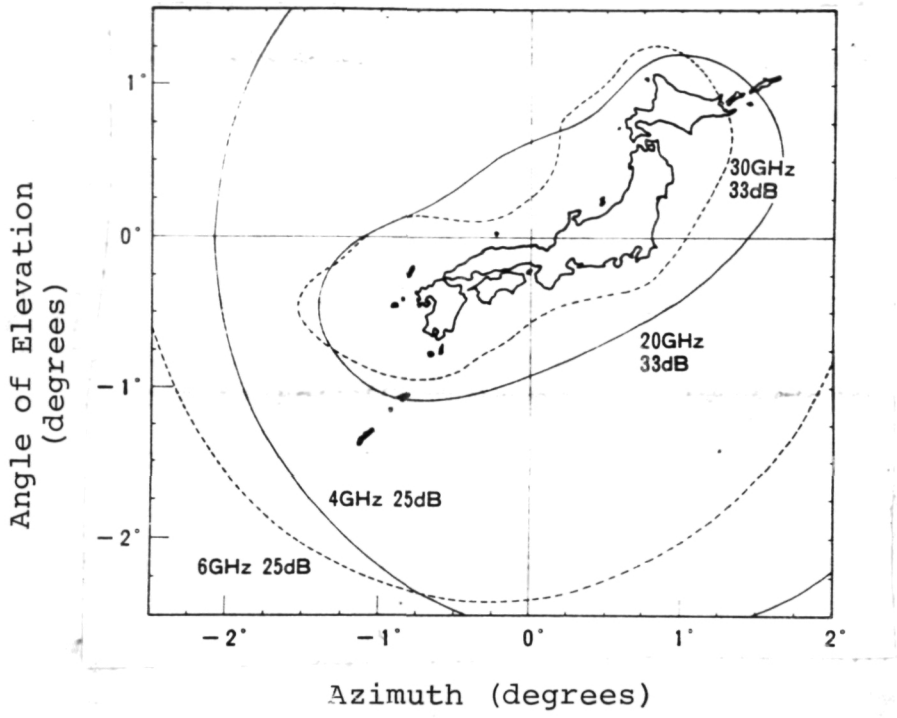
2. A beam has been formed to match the shape of Japan by correction of a reflective mirror surface in the 30/20 GHz band; the entire land of Japan can be covered with circular beams.

By bringing together these research results, it has become possible to produce the antenna for the CS-2 satellite entirely in Japan.

ANTENNA TO BE LOADED ON THE CS-2 SATELLITE

CS-2 SATELLITE ANTENNA PATTERN

/4



PARAMETERS OF ANTENNA TO BE LOADED ON THE CS-2 SATELLITE

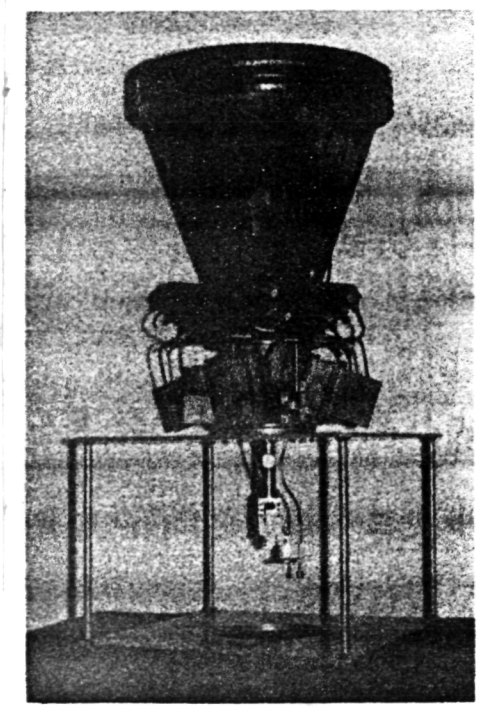
Item	Parameters	Means of Achieving Parameters
Frequency band	30/20 GHz band; 6/4 GHz band; 4 cycle common use	Formation beam horn reflector
Service area and gain	30/20 GHz band: Japan mainland over 33dB 6/4 GHz band: Japan mainland over 25dB	
Diameter of opening	0.95m ϕ	
Accuracy of miror surface	less than 0.2mm RMS	CFRP laminating method and optimum hardened formation condition
Weight	12kg	CFRP and aluminum honeycomb structure; determination of optimum structure by computer simulation
Resistance to surroundings	Resistant to conditions at liftoff such as vibration, shock, and noise	
Temperature	-150°C∿+120°C	Temperature control by thermal shield and partial coating

[1]-2 CS-2 SATELLITE GROUP BRANCHING FILTER /5

This group branching filter was developed to be loaded on the CS-2 communications satellite, and is installed under a Hone reflector shape mirror in order to divide the transmit and receive electrical waves of the 4, 6, 20, and 30 GHz bands into each of the frequency bands.

By combining ultra-high frequency circuit technology with materials technology, high performance, small size, and light weight were achievable; thus succeeding in the domestic production of the group branching filter for the CS-2 satellite.

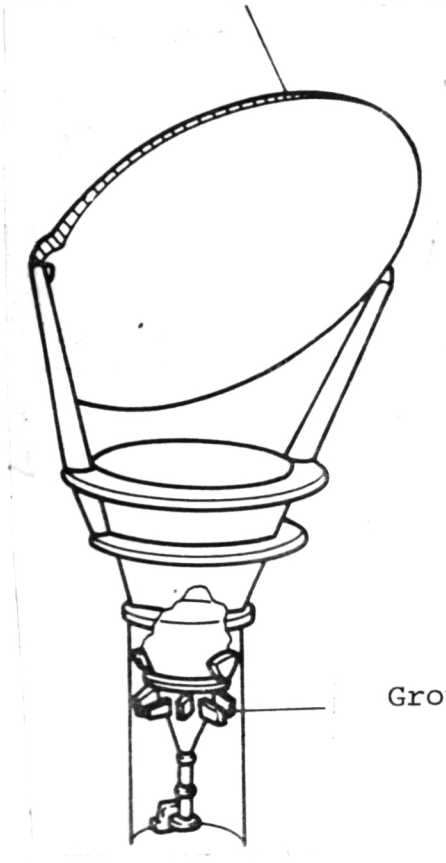
GROUP BRANCHING FILTER FOR THE CS-2 SATELLITE



GROUP BRANCHING FILTER FOR THE CS-2 SATELLITE

/6

Hone reflector shape antenna



Group branching filter

Major Electrical Characteristics

	Input VSWR	Loss	Elliptical bias wave ratio
4 GHz band	less than 1.21	less than 1.1dB	less than 0.6dB
6 GHz band	less than 1.17	less than 1.3dB	less than 0.5dB
20 GHz band	less than 1.16	less than 0.26dB	less than 1.7dB
30 GHz band	less than 1.15	less than 0.26dB	less than 1.2dB

Measuring conditions:

Degree of vacuum: 1×10^{-5} Torr
Temperature range: -30°∿+50°C

Features:

(1) Comprises a wave branching electrical supply system that is small in size and that uses the technology of the 6/4 GHz, 30/20 GHz method

(2) Wide band suppression of high order mode generation by means of combined circuitry

(3) Aluminum and CFRP to achieve a light weight of 3.5 kg

(4) Spin fluctuation minimized by the CS due to the most appropriate design that corresponds to the transmission band

[1]-3 CS-2 SATELLITE REPEATER /7

The CS-2 satellite repeater was developed at the Electrical Communications Research Center. This repeater is the first one in the world for an actual communications satellite that uses frequencies of the 30/20 GHz band.

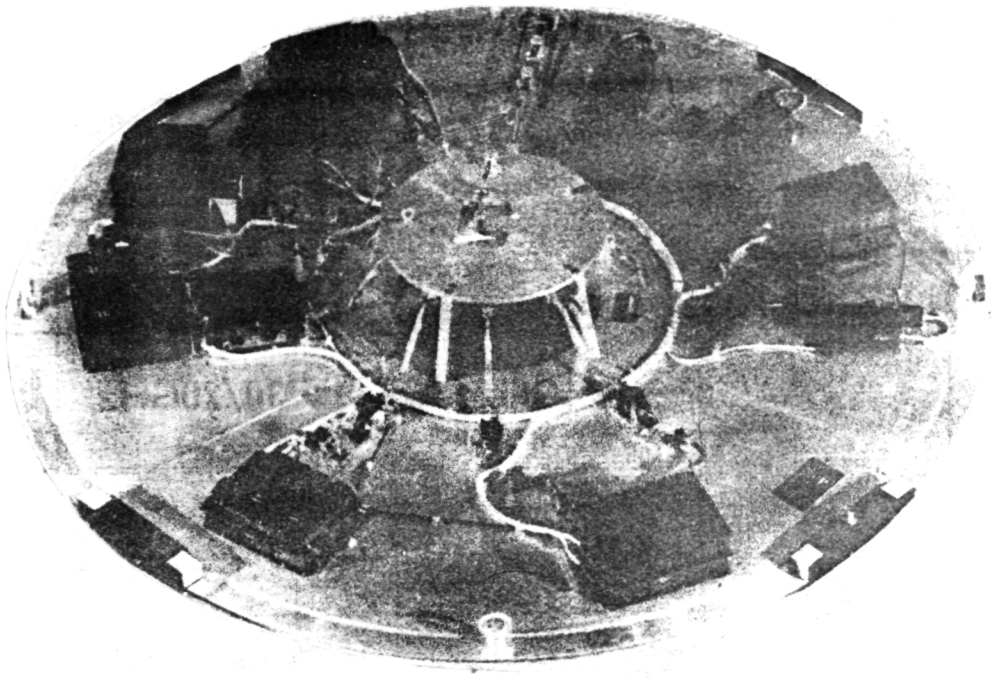
Due to the communications system design technology, circuit technology, high reliance parts technology, and other comprehensive technology of the research center, domestic production was made possible. A high rate of 92% was reached for the domestic production of parts.

MAJOR PARAMETERS

	6/4 GHz	30/20 GHz
Number of systems	2 systems 1 spare system	6 systems 1 beacon system
Band width	180 MHz	130 MHz
Noise index	less than 6.2dB	less than 12dB
Transmit power	greater than 34.5dB	greater than 34dB
Repeater gain	greater than 107dB	greater than 108dB
Adjustable gain mechanism	adjustable attenuator	adjustable attenuator and limiter
Weight	66.0 kg	
Power consumption	less than 295W	
Reliability*	greater than 0.76	

*probability of survival after three years

CS-2 SATELLITE REPEATER /8



[2] INTEGRATED DIGITAL SATELLITE COMMUNICATIONS METHOD /9

The integrated digital satellite communications method has made it possible to transmit data, images, telephonic and various other types of information as digital signals between any two points on earth, by means of satellite. Much is expected for the future of this new communications method.

At the Electrical Communications Research Center, the demand assign time division multiple access (DA-TDMA) method was developed, in which the circuit is set upon the generation of traffic; the circuit is not fixed as in former methods. In this way, the efficiency of the satellite communications circuit can be improved several times over. Also, a small, light earth station with an antenna diameter of 3.3 meters was developed so that it could be installed easily at any location, such as on the roof of

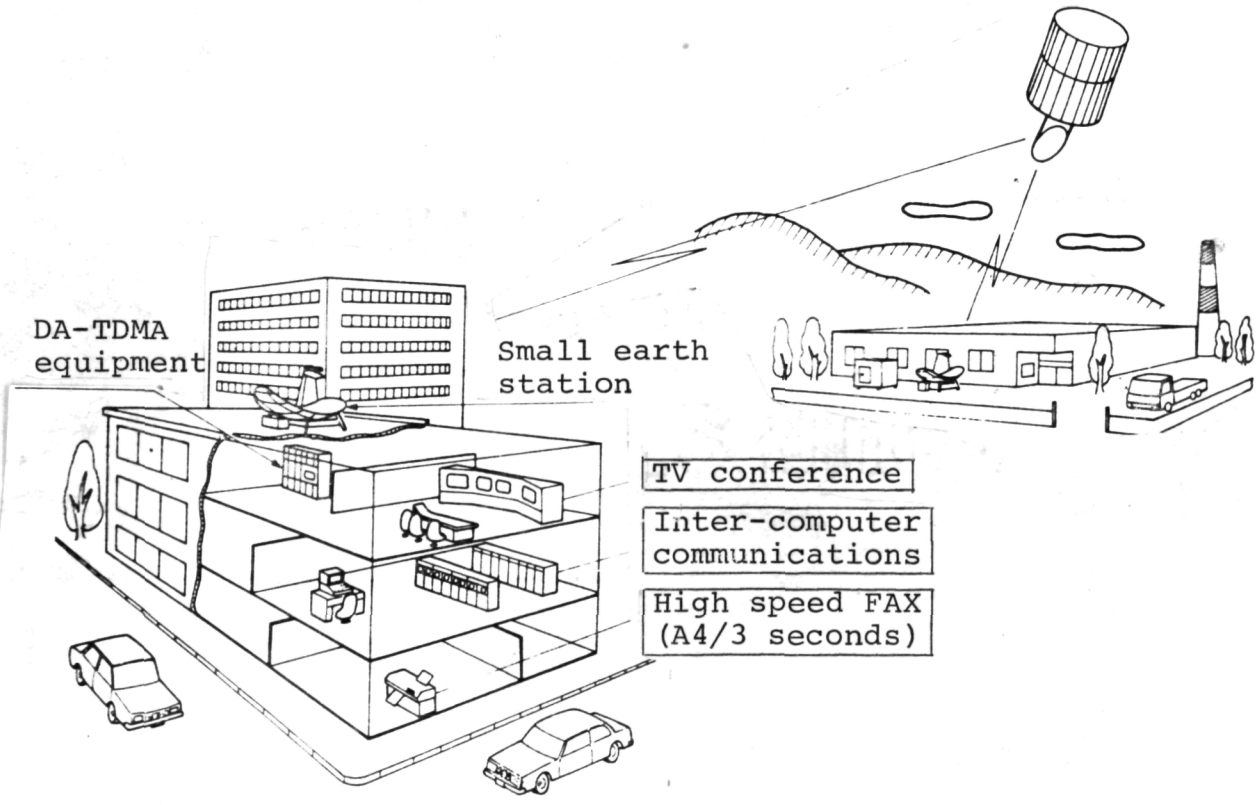
a building.

Data communications, television conferences, packet exchange, and other experiments were carried out using the CS and the DA-TDMA method; and the first success was in July of 1980 (announced July 7, 1980).

After that, experiments proceeded such as high-speed facsimile and connection with land methods, and favorable results were obtained.

Through the success of these experiments, satellite communications technology that can efficiently perform a variety of services has reached the level of practical use.

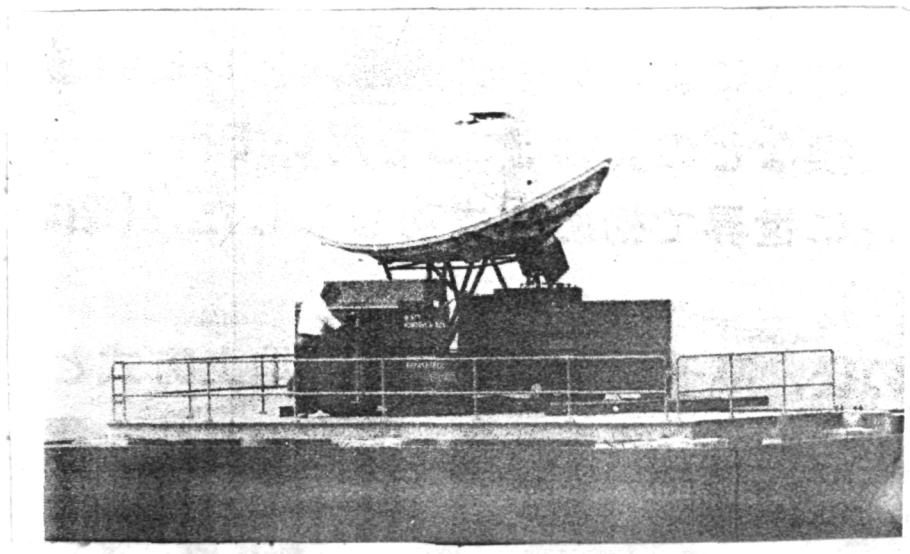
INTEGRATED DIGITAL SATELLITE COMMUNICATIONS METHOD /10



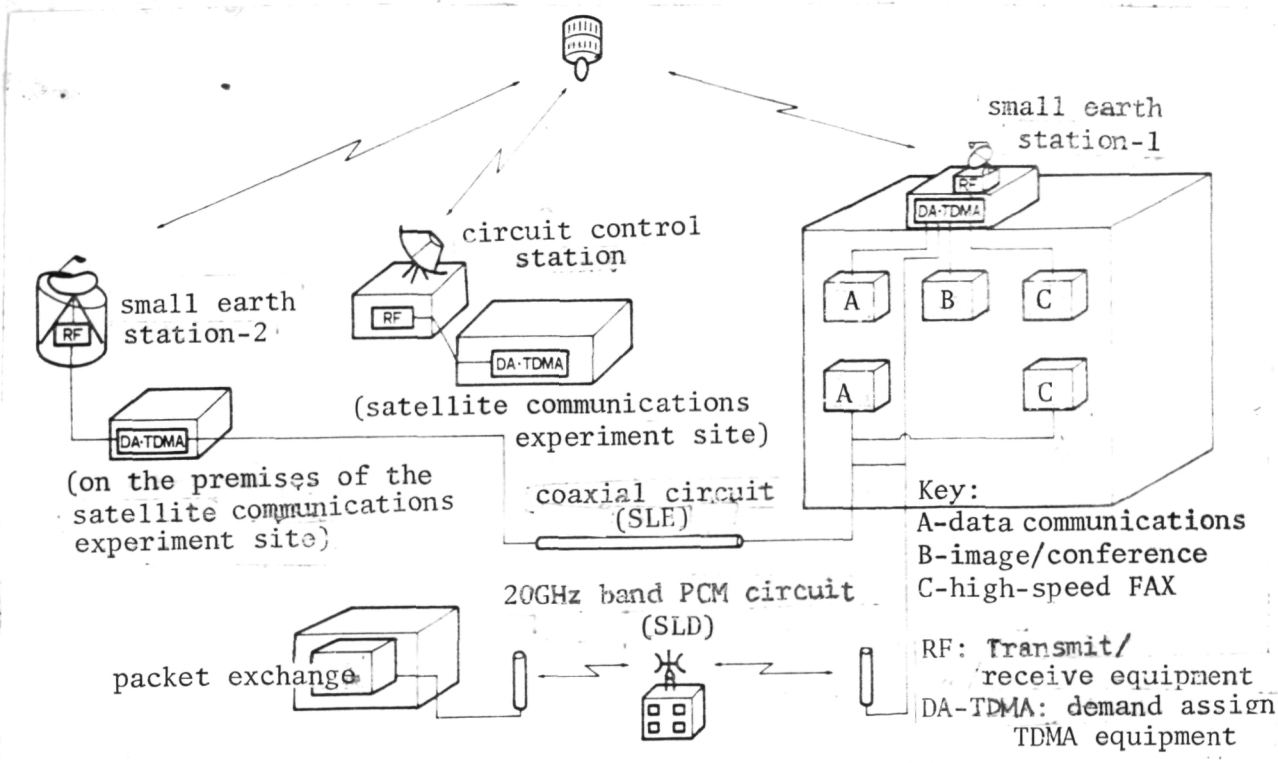
A simplified earth station is installed on the roof of a building or factory to achieve services such as television conferences.

Effort is being made to distribute these services throughout the entire country [of Japan]. The experiment with this method, which leads the world using the 30/20 GHz band, was a success.

SMALL EARTH STATION



COMPOSITION OF THE INTEGRATED DIGITAL SATELLITE COMMUNICATIONS EXPERIMENTAL SYSTEM /11



EXPERIMENT RESULTS REGARDING INTEGRATED DIGITAL SATELLITE COMMUNICATIONS

/11

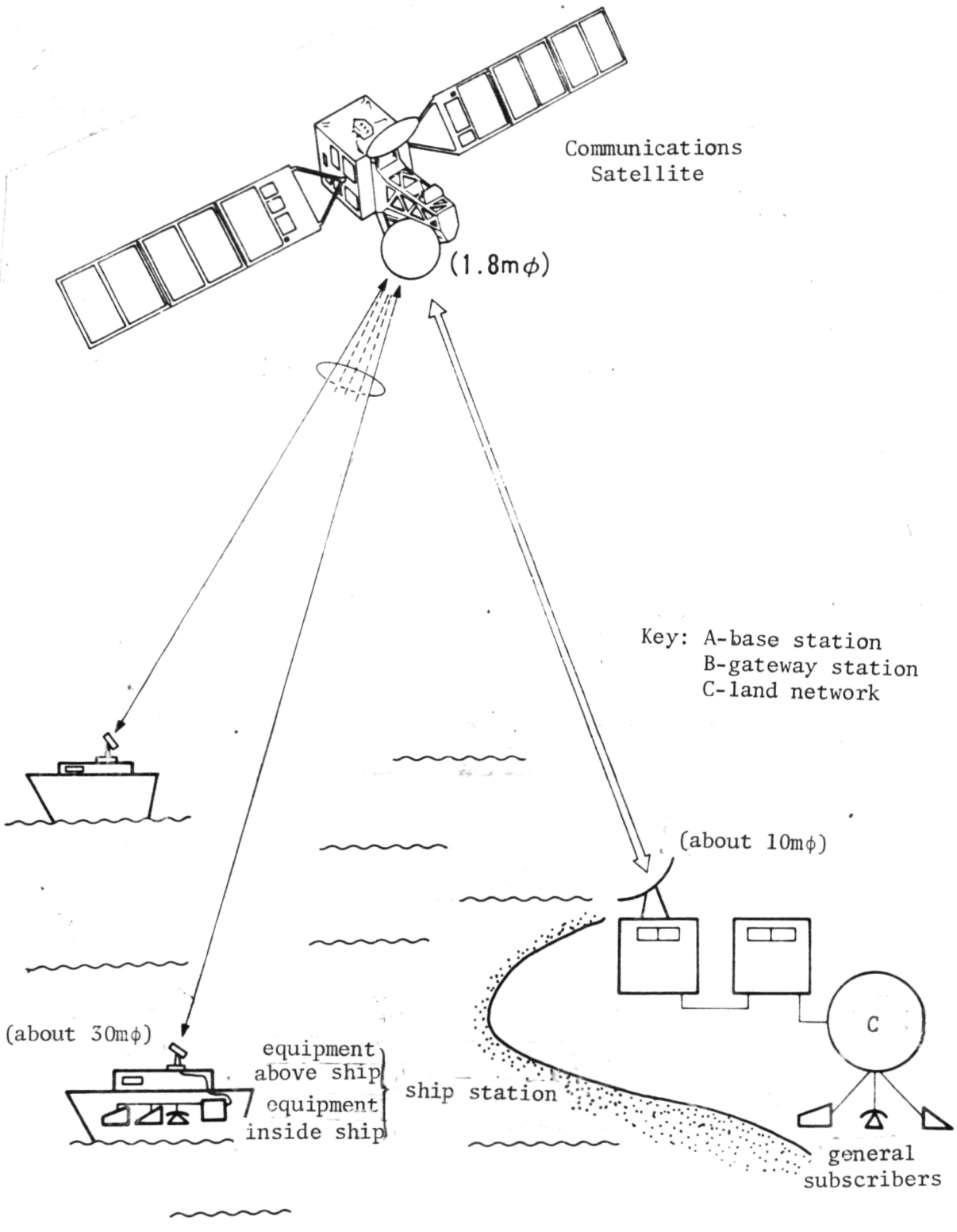
Experiment (service)	Contents and Results of Experiment
Data communi-cations	◦An experiment was performed by transmitting 1.54Mb/s data between two computers, and it was confirmed that DCNA could also be adapted to the satellite circuit which has delay time. ◦A 64Kb/s both-direction communications circuit was established from one computer to two computers, and identical information communication experiments were performed; it was confirmed that identical information communication could be done with HDLC.
Television conferences	◦An economical encoder for 6.3Mb/s moving images, 1.5Mb/s still image transmission equipment that can transmit a one-page image in about 2 seconds, and an encoder for 256Kb/s high-quality voice transmission that can transmit voice of a 10KHz bandwidth were developed and tested. As a result, it was confirmed that quality was sufficient for television conferences.
Packet exchange	◦The following 3 experiments were performed: mixing or switchover method of land circuit and satellite circuit; identical information communication; and packet transmission method whereby 3 packet switchboards are connected with a 64Kb/s satellite circuit. As a result, the effectiveness of the communications method that deals with the newly developed transmission delay time and the interstation signal method for identical information communication was confirmed.
High-speed facsimile	◦The 1.544 Mb/s high-speed facsimile equipment that can transmit one page of A4 size paper in 3 seconds was developed and tested. Good picture quality was confirmed. ◦As for identical information communications, equipment that compresses the response from the landing terminal into 64Kb/s was developed and tested. As a result, effective utilization of the satellite circuit was confirmed.
Connection-with-land methods	◦Experiments were performed for the transmission of still pictures regarding the method where the satellite circuit is connected with a land method. As a result, it was confirmed that a variety of signals could be transmitted with sufficient quality by combining land methods with satellite.

[3] SHIP-TO-SATELLITE COMMUNICATIONS METHOD /12

Ship-to-satellite communications is one service that makes use of the feature of satellite communications whereby a uniform service can be supplied over a large area.

At the Electrical Communications Research Center, research is being carried out on the communications method, ship station equipment, and satellite equipment with the goal that even a small 20-ton ship could be used for communication purposes. Equipment to be carried on small ships for ship-to-satellite communications and a satellite repeator (bread board model) have been successfully developed on a trial basis.

OVERVIEW OF SHIP-TO-SATELLITE COMMUNICATIONS METHOD /13



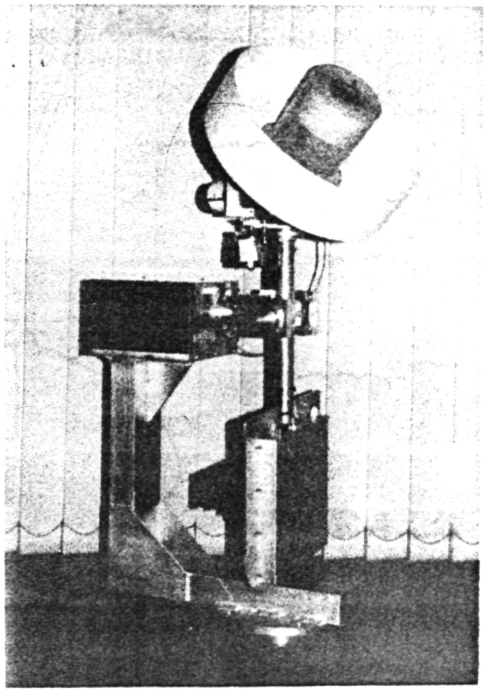
[3]-1 EQUIPMENT TO BE CARRIED ON SMALL SHIPS FOR SHIP-TO-SATELLITE COMMUNICATION

/14

This equipment has been developed on a trial basis in conjunction with the results of research to date, in order to achieve ship-to-satellite communications service. A new, simplified method has been used to compensate for the rocking of the ship and shadowing of the antenna.

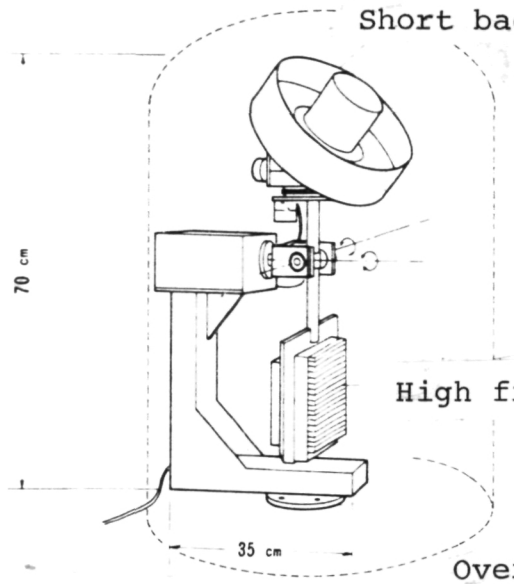
By means of this trial equipment, an economical outlook has been obtained for shipboard equipment. Plans now are to realize even smaller and more economical equipment.

EQUIPMENT TO BE CARRIED ON SMALL SHIPS FOR SHIP-TO-SATELLITE COMMUNICATION



COMPOSITION OF COMMUNICATIONS EQUIPMENT
FOR SMALL SHIPS

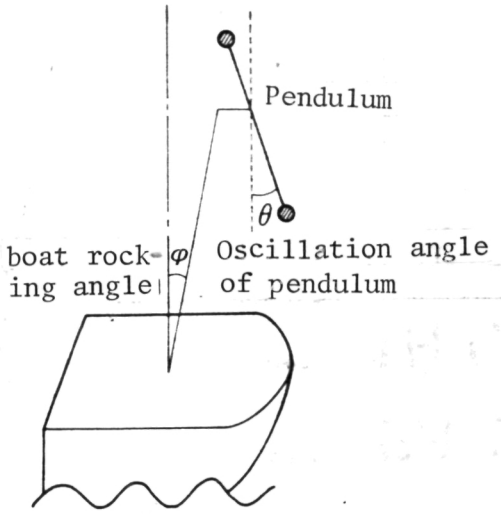
/15



Features:

1. Small, high-efficiency antenna with low side lobe level that eliminates waves reflected on the ocean surface
2. Simplified pursuit method (azimuth and angle of elevation methods)
3. Simplified rocking compensation method (pendulum passive rocking compensation method)
4. Compact structure which can be contained in a 50cm diameter ray dome

PASSIVE ROCKING COMPENSATION METHOD



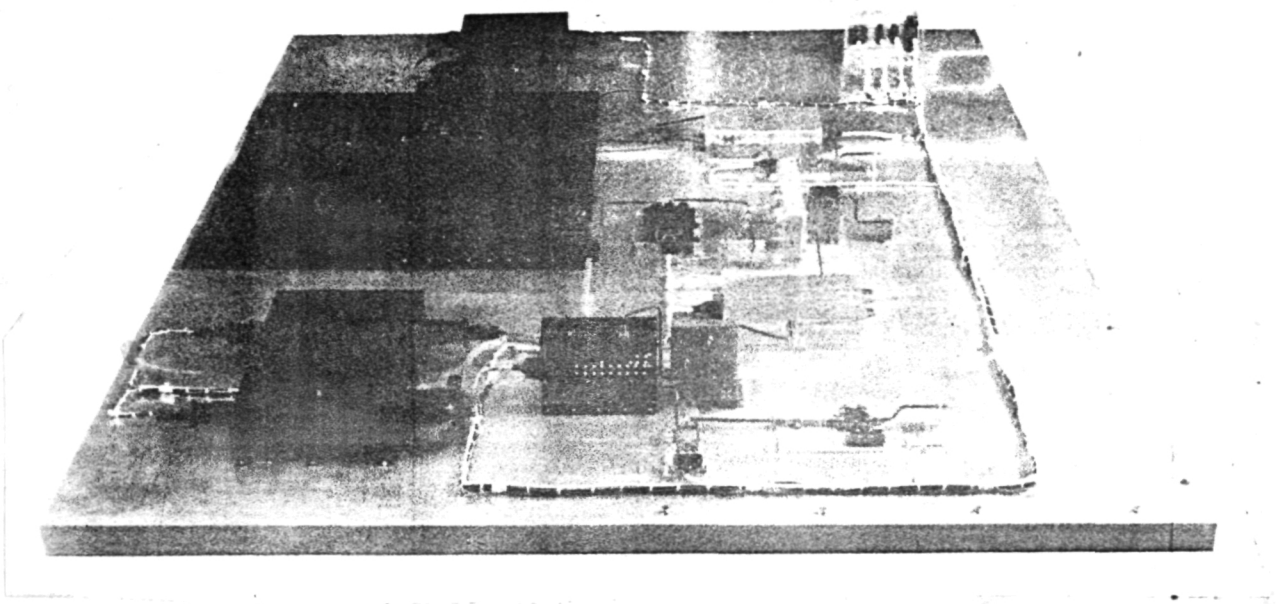
Ordinary antenna rocking compensation equipment uses a method whereby a motor moves the antenna and a mechanism for automatic control. The equipment is heavy and expensive. Hence, by supporting at one point between the antenna and the transmit/receive equipment and making a pendulum-like structure, antenna rocking compensation equipment that reduces the swinging of the antenna was made on a trial basis. Prospects for actual development are good.

[3]-2 SATELLITE REPEATER FOR SHIP-TO-SATELLITE COMMUNICATIONS (BREADBOARD MODEL) /16

The satellite repeater for ship-to-satellite communications was developed on a trial basis in conjunction with past research to achieve ship-to-satellite communication service. It is a high-output, high-efficiency satellite repeater.

Future plans are to complete a ship-to-satellite communications repeater with a thermal design and structural design based on the results of this trial repeater.

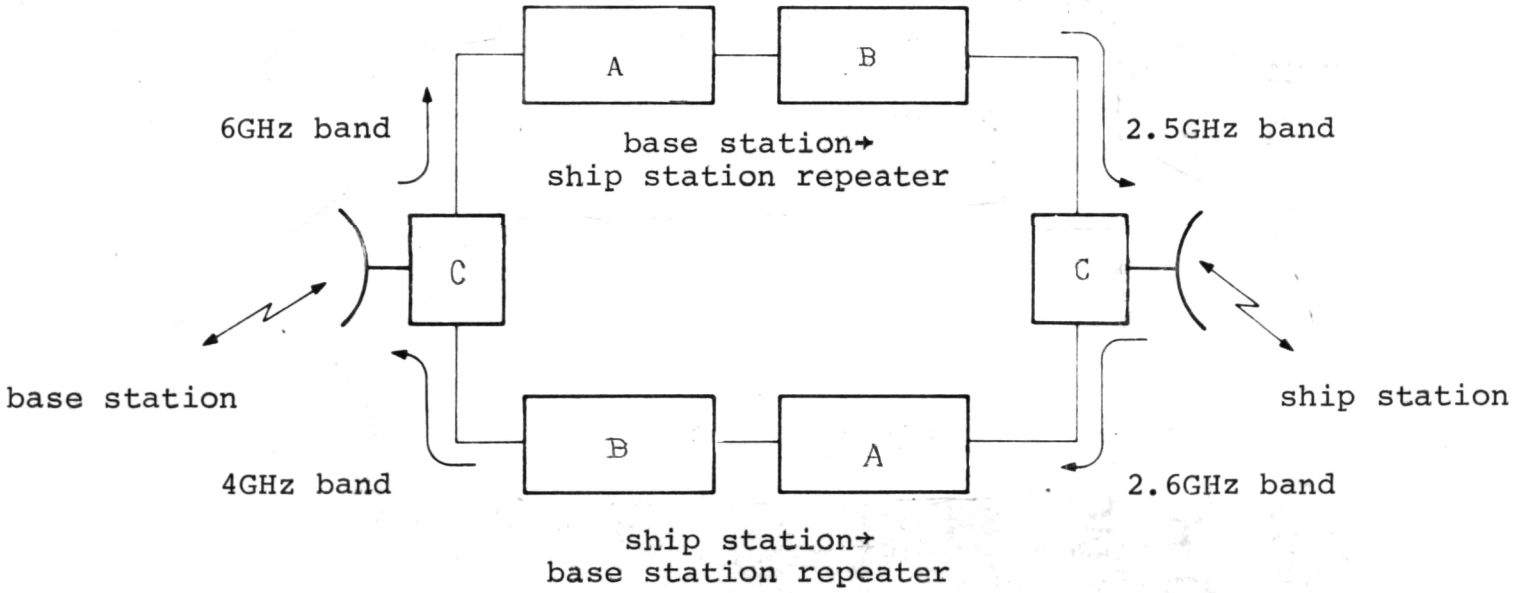
SATELLITE REPEATER FOR SHIP-TO-SATELLITE COMMUNICATIONS (BREADBOARD MODEL)



PARAMETERS AND COMPOSITION OF SATELLITE REPEATER FOR SHIP COMMUNICATIONS (BREADBOARD MODEL) /17

	Base Station→ Ship Station Repeater	Ship Station→ Base Station Repeater
Frequency	2.6/2.5GHz band (feeder link is 6/4HHz band)	
Noise index	2.8dB	3.4dB
Transmit output	30W	2W
Bandwidth	15MHz	15MHz
Repeater gain	115dB	118dB
Signal vs. 3rd order cross modulation distortion rate	greater than 26dB	greater than 28dB
Power consumption	220 W	
Weight	28kg	

[Composition of Satellite Repeater for Ship Communications]



Key: A - Receiver
B - Power amplifier
C - Transmit and receive branching filter

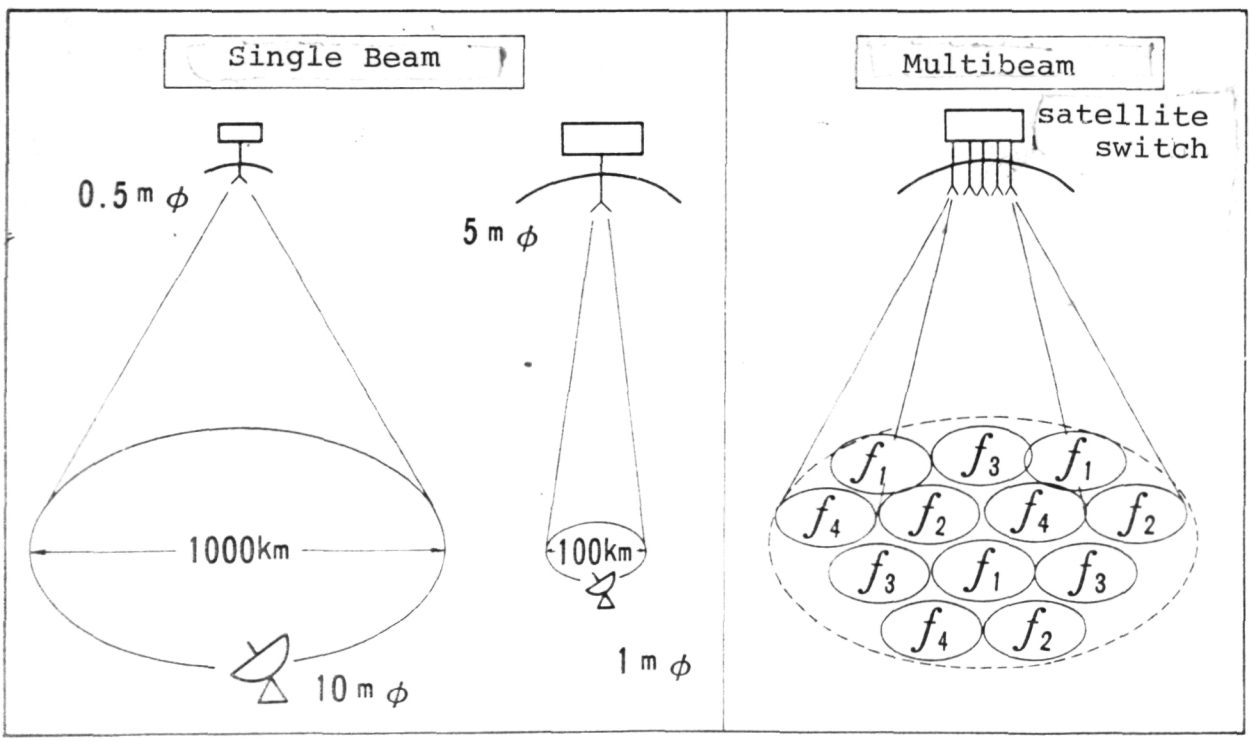
4 MULTIBEAM SATELLITE COMMUNICATIONS METHOD (1)

-Summary-

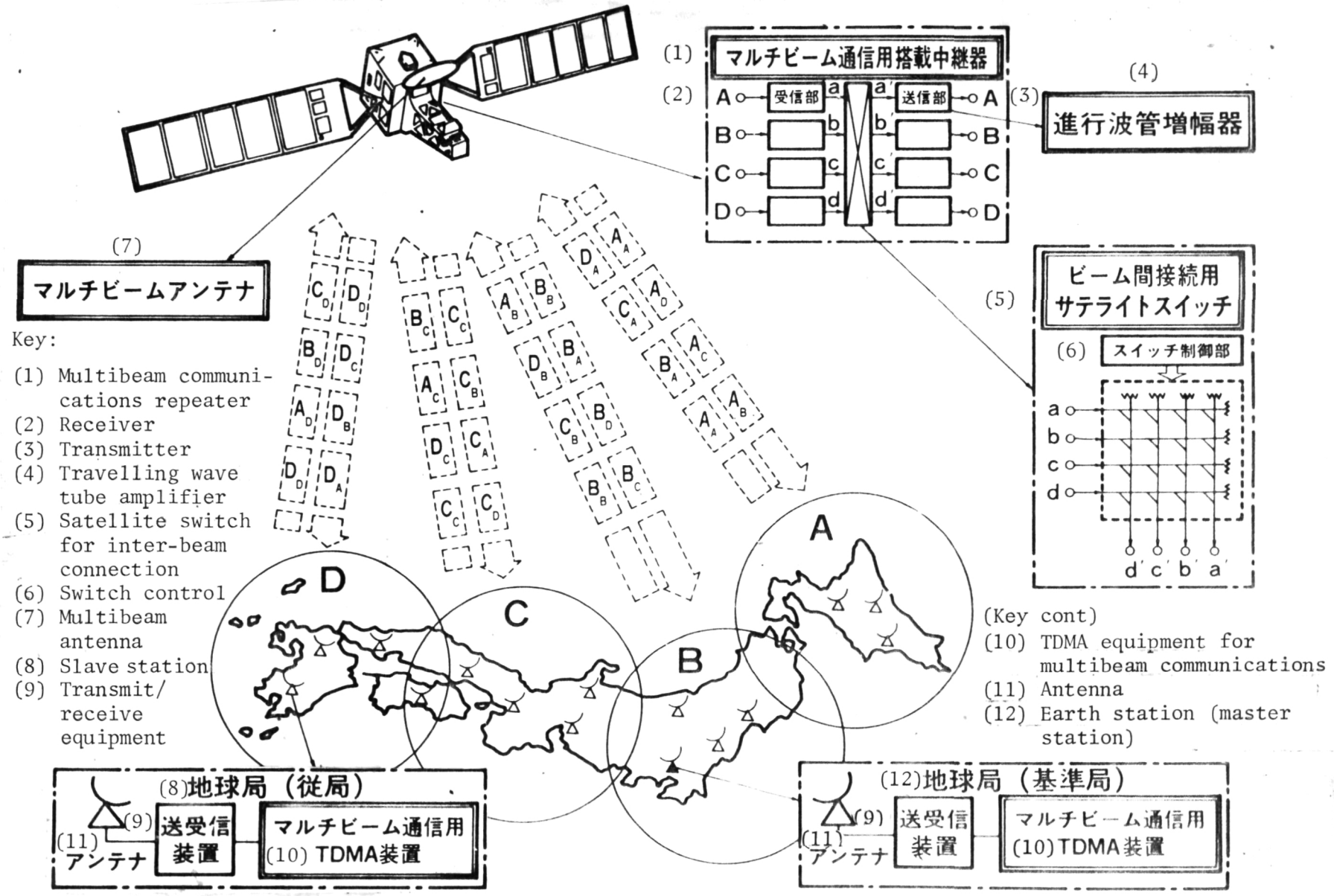
The multibeam satellite communications method involves dividing Japan into several zones and covering each zone with narrow beams from the satellite. When compared with the conventional single beam method which covers the whole country with one beam, the reception level of electrical waves on the ground is higher, transmission capacity is larger, the earth station is smaller, cost is lower, effectiveness of static satellite orbit is utilized, and frequencies are more effectively used.

At the Electrical Communications Research Center, further research is being conducted on the multibeam communications satellite repeater which contains the multibeam TDMA equipment and inter-beam connection satellite switch, and also on the 30/20GHz band multibeam satellite antenna.

CONCEPT OF MULTIBEAM SATELLITE COMMUNICATIONS METHOD



COMPOSITION OF MULTIBEAM SATELLITE COMMUNICATIONS METHOD



Key:

(1) Multibeam communications repeater
(2) Receiver
(3) Transmitter
(4) Travelling wave tube amplifier
(5) Satellite switch for inter-beam connection
(6) Switch control
(7) Multibeam antenna
(8) Slave station
(9) Transmit/ receive equipment

(Key cont)

(10) TDMA equipment for multibeam communications
(11) Antenna
(12) Earth station (master station)

EFFECTIVENESS OF MULTIBEAM SATELLITE COMMUNICATION METHOD

/20

(1) Increased transmission capacity

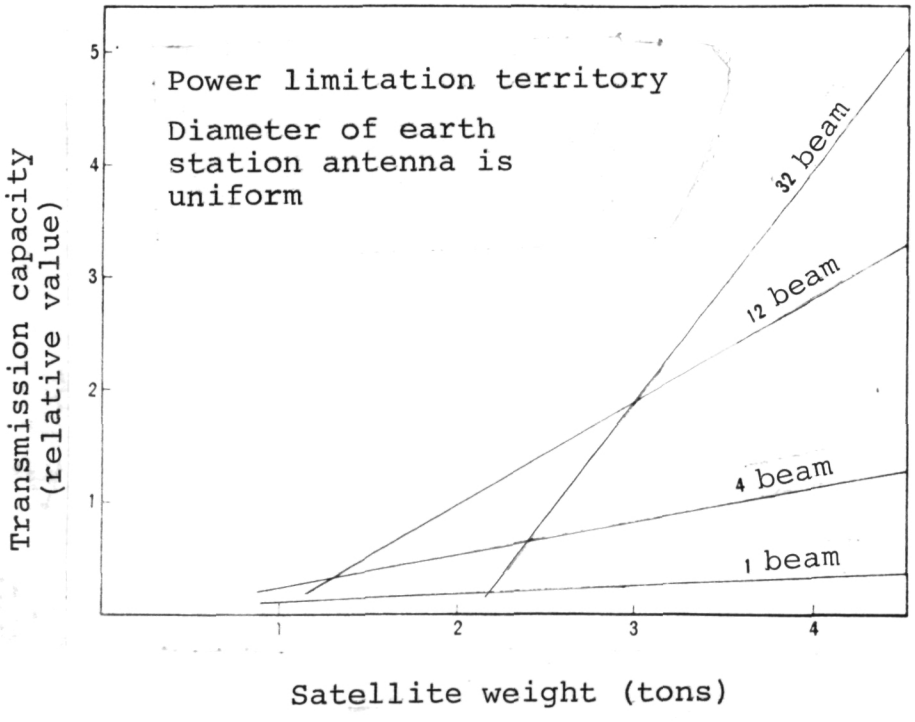
(2) Improved economy

(3) Smaller and more economical earth station

(4) Effective utilization of stationary orbit

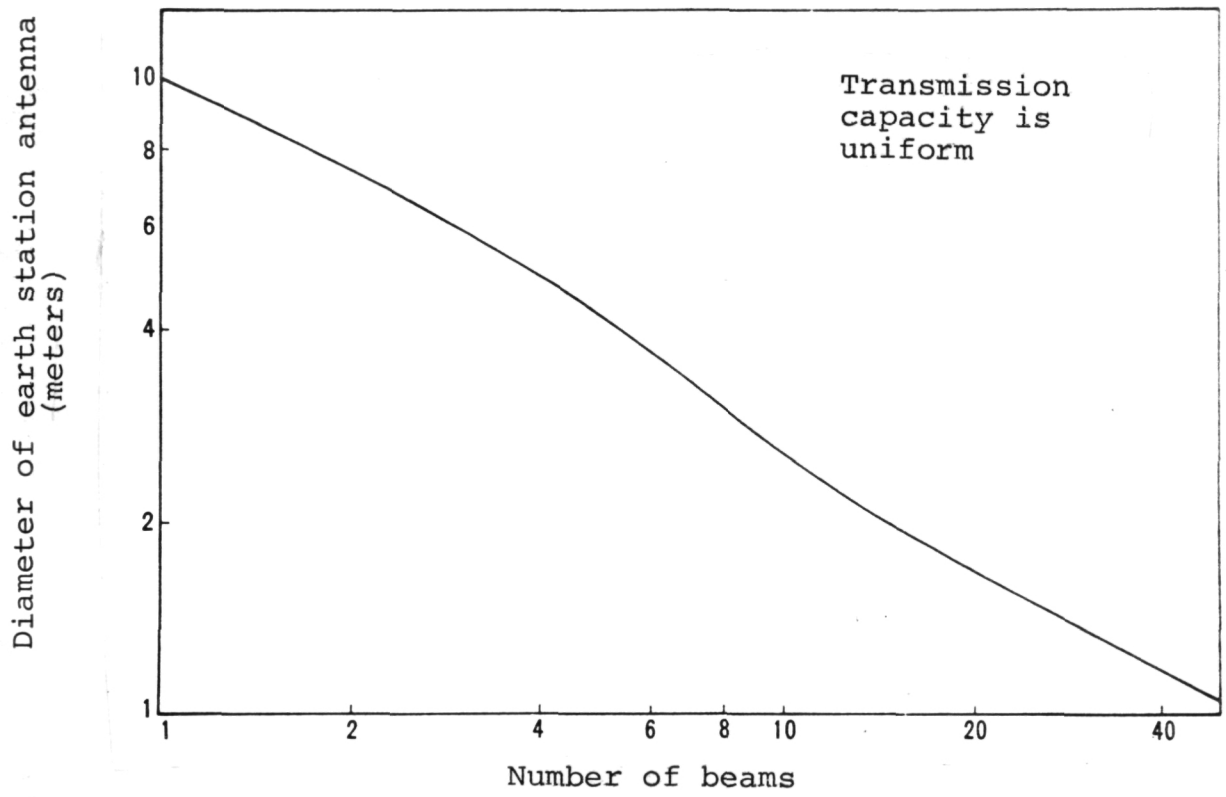
(5) Effective utilization of frequencies

INCREASE OF TRANSMISSION CAPACITY

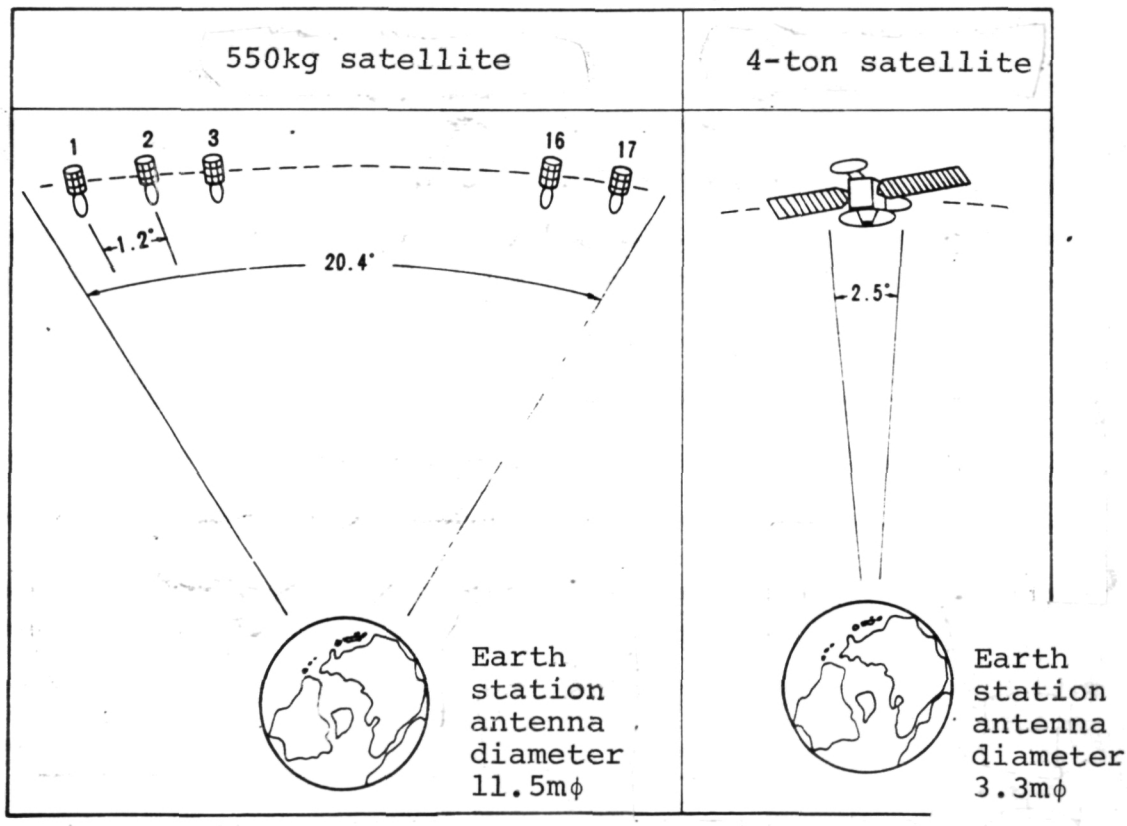


MINIATURIZATION OF EARTH STATION

/21

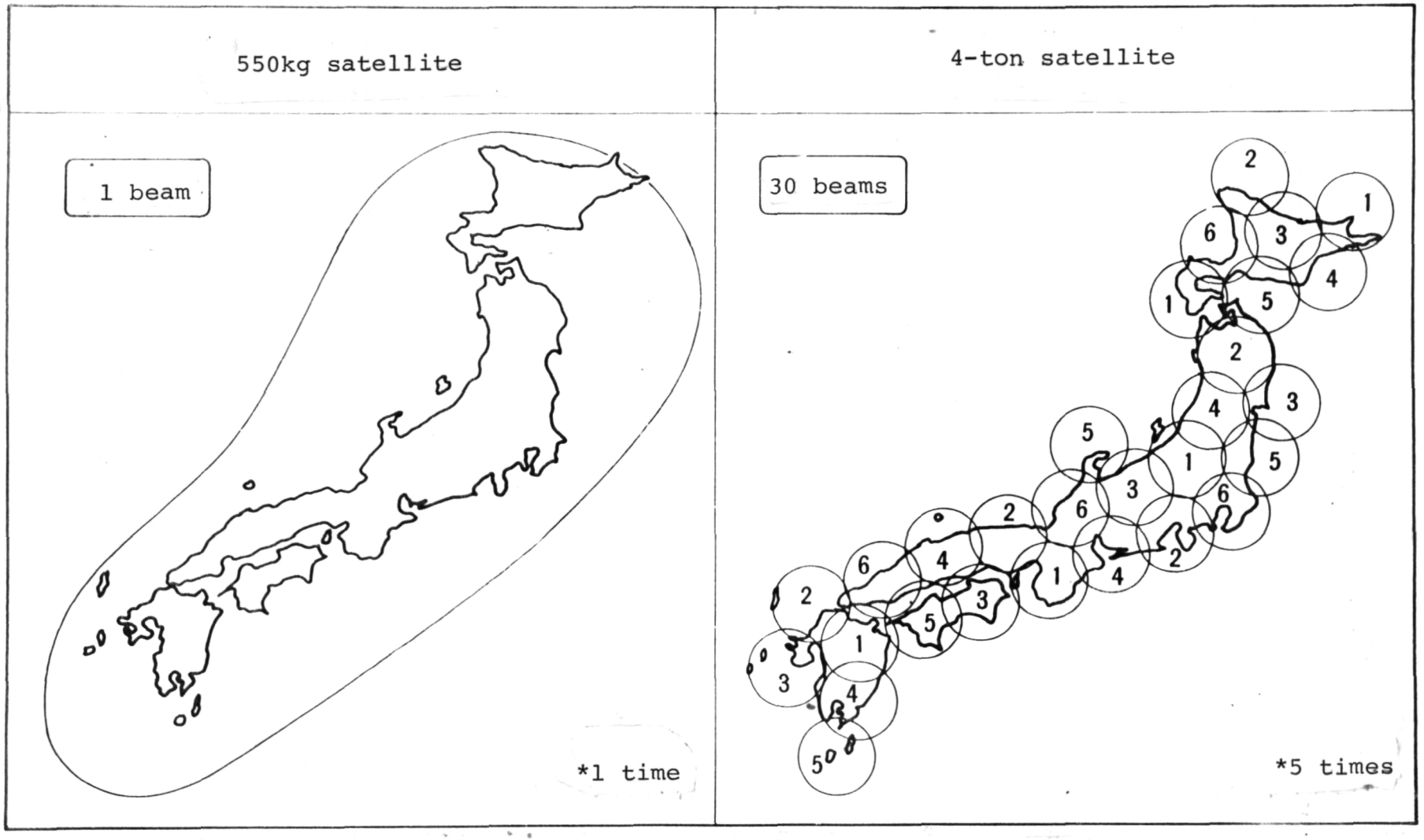


EFFECTIVE UTILIZATION OF STATIONARY SATELLITE ORBIT



(Comparison of 100,000 channel transmission capacity)

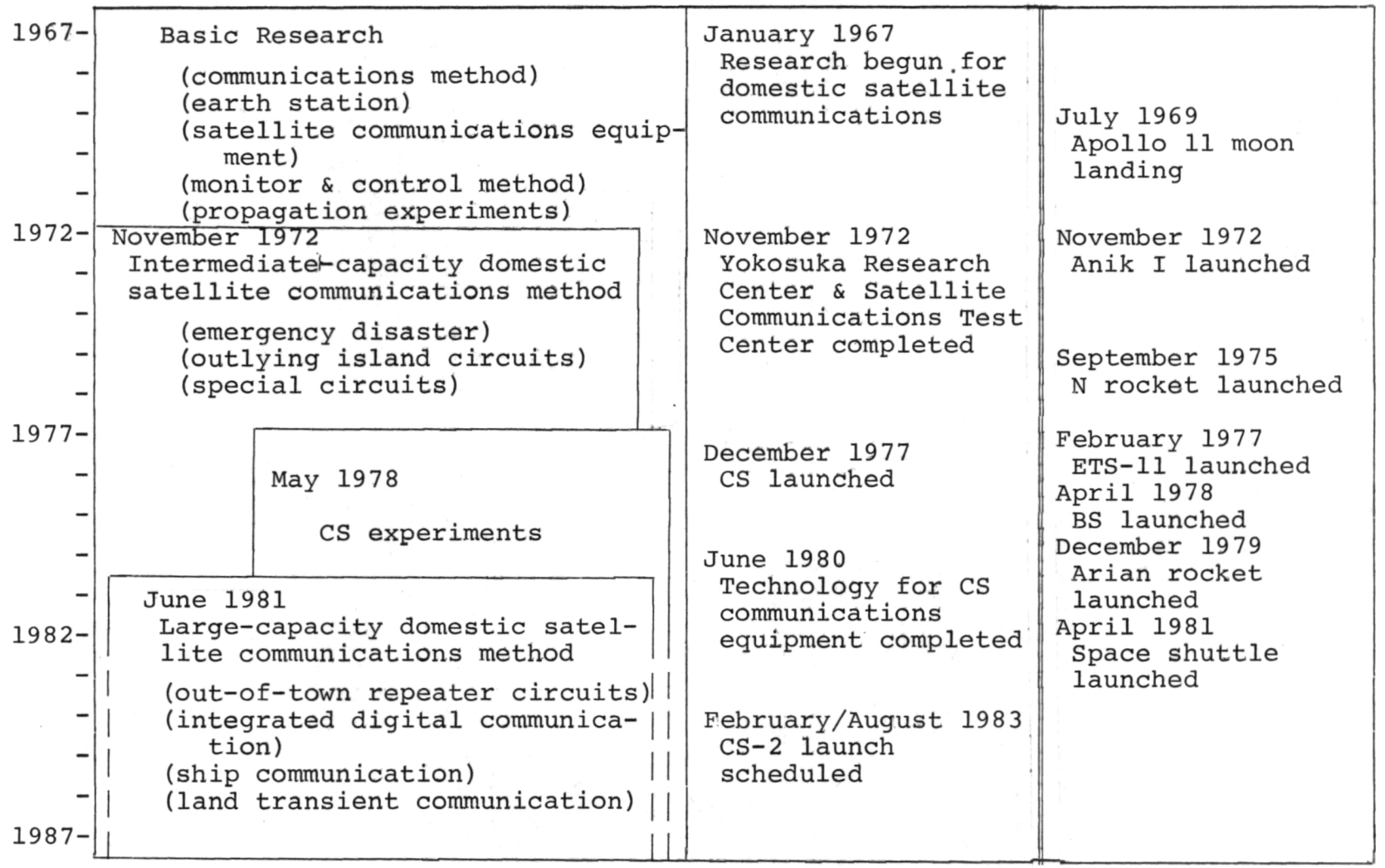
EFFECTIVE UTILIZATION OF FREQUENCIES



*Number of times a frequency can be used repeatedly

DETAILS OF RESEARCH ON DOMESTIC SATELLITE COMMUNICATIONS METHOD

/23



RESEARCH CIRCUMSTANCES OF MULTIBEAM SATELLITE COMMUNICATIONS METHOD

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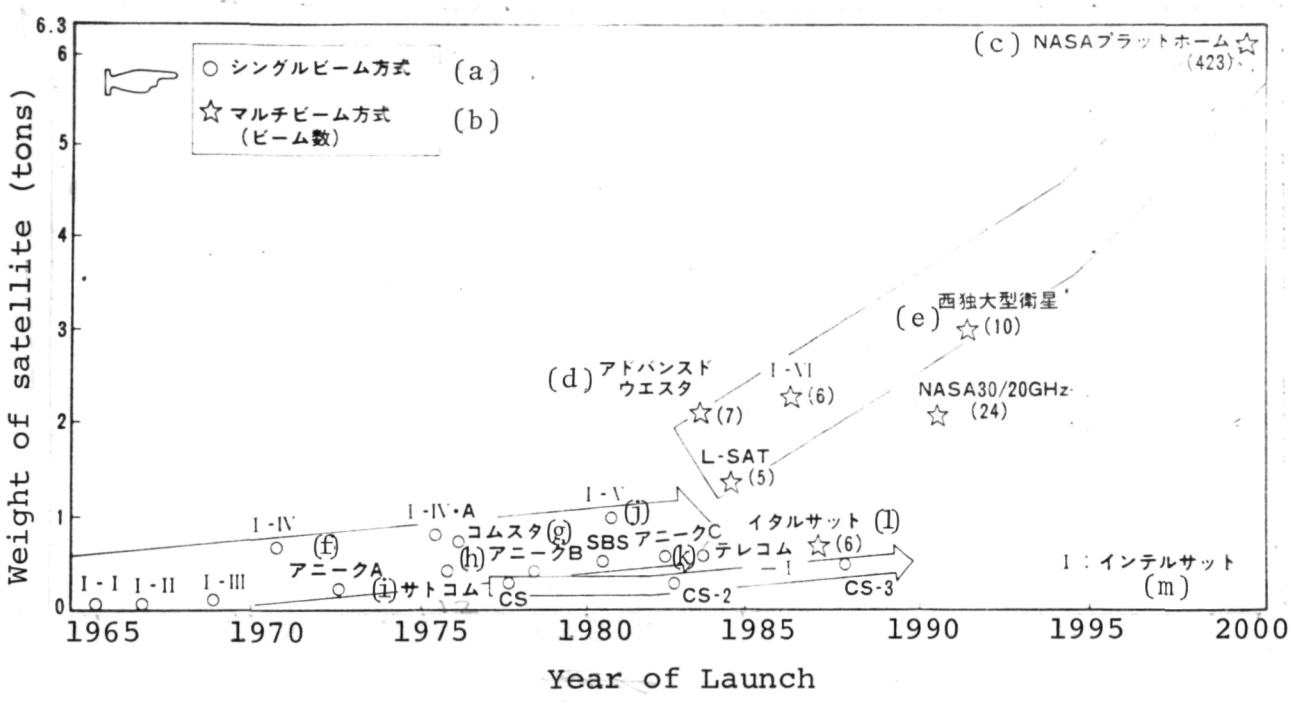
		Frequency	Switch Type	Switch Plan	Bit Rate	Phase of Research	Year Annc'd
Intellsat (Intellsat VI)		6/4GHz	Microwave (4GHz)	6x6	120Mb/s	theoretical examination	1981
	Comsat	6/4GHz	Microwave (4GHz)	16x16	60Mb/s	satellite experiment (1976)	1978
	KDD	6/4GHz	Microwave (4GHz)	8x8	---	indoor experiment	1976
	Fujitsu	6/4GHz	Microwave (4GHz)	2x2	40Mb/s	indoor experiment	1974
	NEC	6/4GHz	Microwave (4GHz)	4x4	---	indoor experiment	1980
	FACC, Inc.	6/4GHz	Microwave (4GHz)	4x4	120Mb/s	indoor experiment	1982
Western Union (Advanced Westa)		14/12MHz	Microwave (4GHz)	4x4	250Mb/s	scheduled launch 1983	1978
NASA	GE	30/20GHz	Microwave (3∿8GHz)	100x100	550Mb/s	theoretical examination	1981
	Motorola	30/20GHz	Baseband	32x32	550, 220, 110, 27.5 Mb/s	experimental basic hardware	1981
ESA Marconi (L-SAT)		14/12GHz	Microwave (———)	4x4	25Mb/s	theoretical examination	1982
Italy Nat'l Research Center (Italsat)		30/20GHz	Baseband	9x12	120Mb/s (360Mb/s)	theoretical examination	1981
Electrical Communications Research Center		30/20GHz	Microwave (1.8GHz)	4x4	200Mb/s	satellite experiment (1982)	1982

MULTIBEAM SATELLITE PLAN FOR VARIOUS COUNTRIES

(1) 打上げ年	(2) 衛星名	(3) 機関名 (国)	(4) ビーム数	(5) 周波数帯 (GHz)	(6) 衛星重量 (t)
1983	アドバンスド ウェスタ (7)	ウェスタンユニオン (米国) (8)	7	6/4 14/12	2
1984	L-SAT (実験用) (9)	ESA (欧州) (10)	6	14/12 30/20	1.4
1986	インテルサット -VI (11)	インテルサット (12)	6	6/4 14/12	2.3
1987	イタルサット (13)(実験用)	イタリア郵電省 (14)(イタリア)	6	30/20	0.7
1990	NASA30/20 GHz 衛星(15)	NASA (米国)(16)	24	30/20	2
1992	西独大型衛星 (17)	西独郵電省 (西独)(18)	10	30/20	3.4
2000	NASA (19) プラットホーム	NASA (20) (米国)	423	6/4 14/12 30/20	6.3

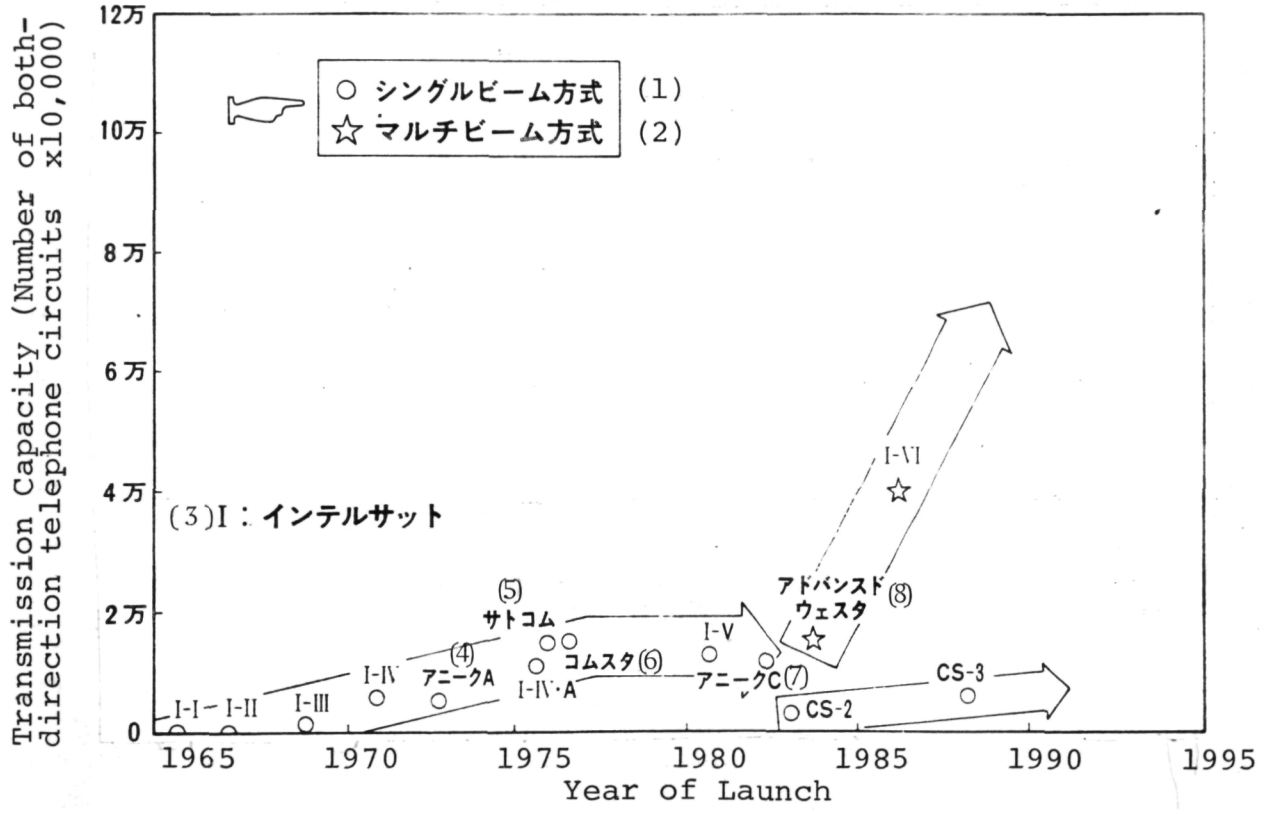
Key: (1) Year to be launched
(2) Name of satellite
(3) Name of organization (country)
(4) Number of beams
(5) Frequency band (GHz)
(6) Sateliite weight (tons)
(7) Advanced Westa
(8) Western Union (USA)
(9) L-SAT (experimental use)
(10) ESA (Europe)
(11) Intelsat-VI
(12) Intelsat [Japan]
(13) Italsat (experimental use)
(14) Italian Ministry of Posts and Telecommunications (Italy)
(15) NASA 30/20GHz satellite
(16) NASA (USA)
(17) West German large satellite
(18) West German Ministry of Posts and Telecommunications (West Germany)
(19) NASA Platform (20) NASA (USA)

TENDENCIES TOWARDS MULTIBEAM AND LARGE SIZE SATELLITES



Key:
(a) Single beam method
(b) Multi beam method (number of beams)
(c) NASA Platform (423)
(d) Advanced Westa (7)
(e) West German large satellite (10)
(f) Anik A
(g) Comsta
(h) Anik B
(i) Satcom
(j) Anik C
(k) Telecom
(l) Italsat (6)
(m) I: Intelsat

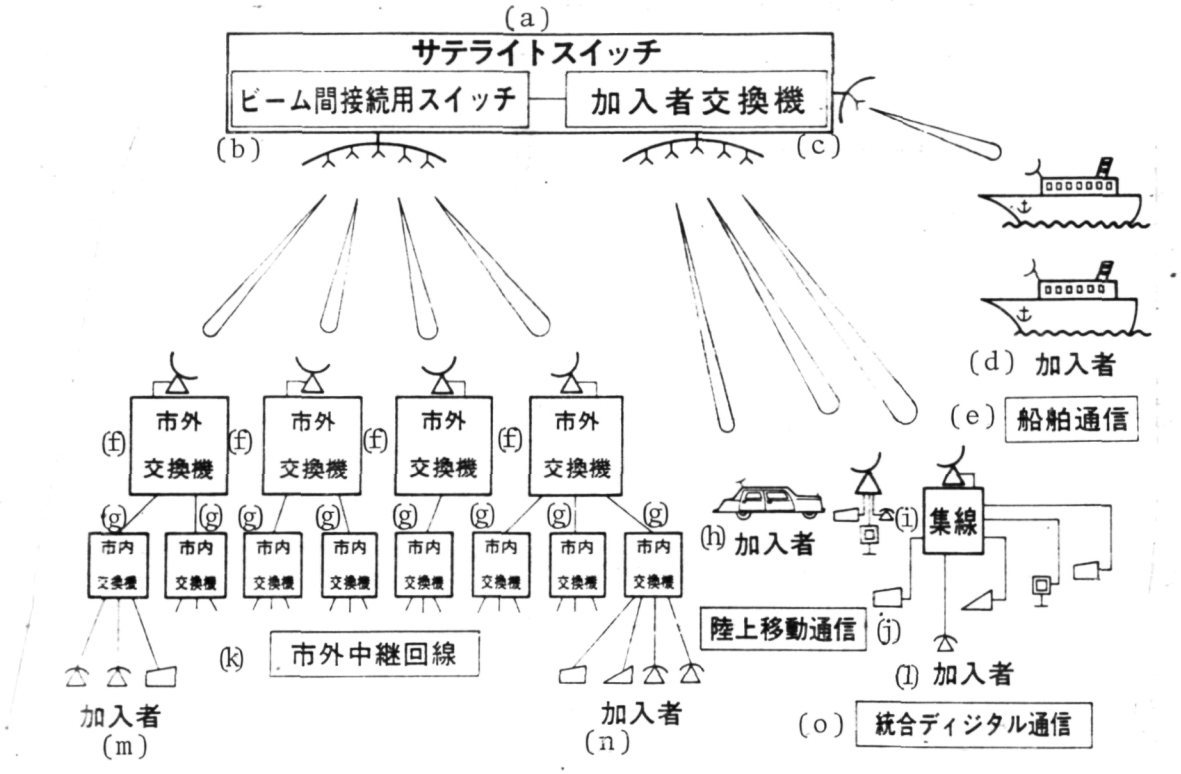
TENDENCIES TOWARDS INCREASING CAPACITIES



Key:
(1) Single beam method
(2) Multibeam method
(3) I: Intelsat
(4) Anik A
(5) Satcom
(6) Comsta
(7) Anik C
(8) Advanced Westa

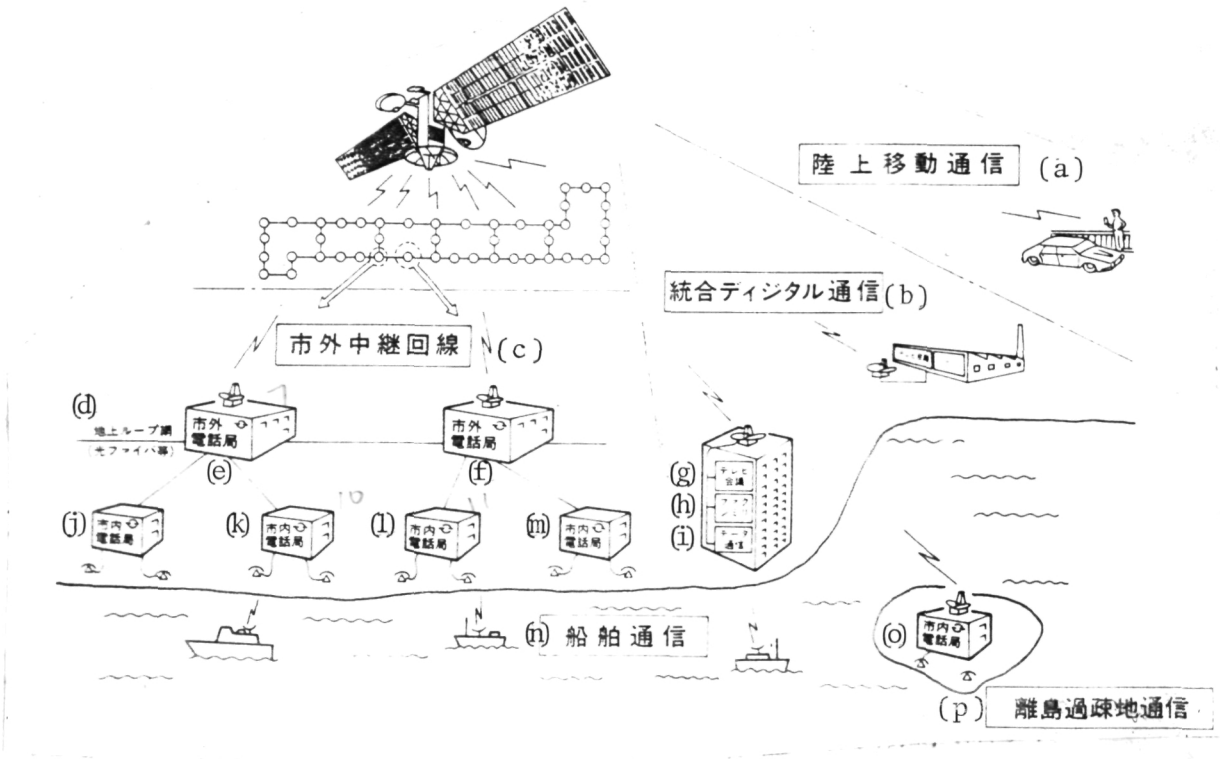
FUTURE SATELLITE COMMUNICATIONS

/26



Key:
(a) Satellite switch
(b) Inter-beam connection switch
(c) Subscriber exchange equipment
(d) Subscriber
(e) Ship communications
(f) Out-of-town exchange equipment
(g) Local exchange equipment
(h) Subscriber
(i) Line collector
(j) Land mobile communications
(k) Out-of-town repeater circuit
(l) Subscriber
(m) Subscriber
(n) Subscriber
(o) Integrated digital communications

ADAPTATION OF SATELLITE COMMUNICATION
TO HIGH LEVEL INFORMATION COMMUNICATION SYSTEM INS



Key:
(a) Land mobile communications
(b) Integrated digital communications
(c) Out-of-town repeater circuit
(d) Land loop network (optical fiber, etc.)
(e) Out-of-town telephone station
(f) Out-of-town telephone station
(g) Television conferences
(h) Facsimile
(i) Data communications
(j) Local telephone station
(k) Local telephone station
(l) Local telephone station
(m) Local telephone station
(n) Ship communications
(o) Local telephone station
(p) Communications for outlying islands and isolated land areas

NEW TECHNOLOGY REQUIRED FOR MULTIBEAM COMMUNICATIONS SATELLITE

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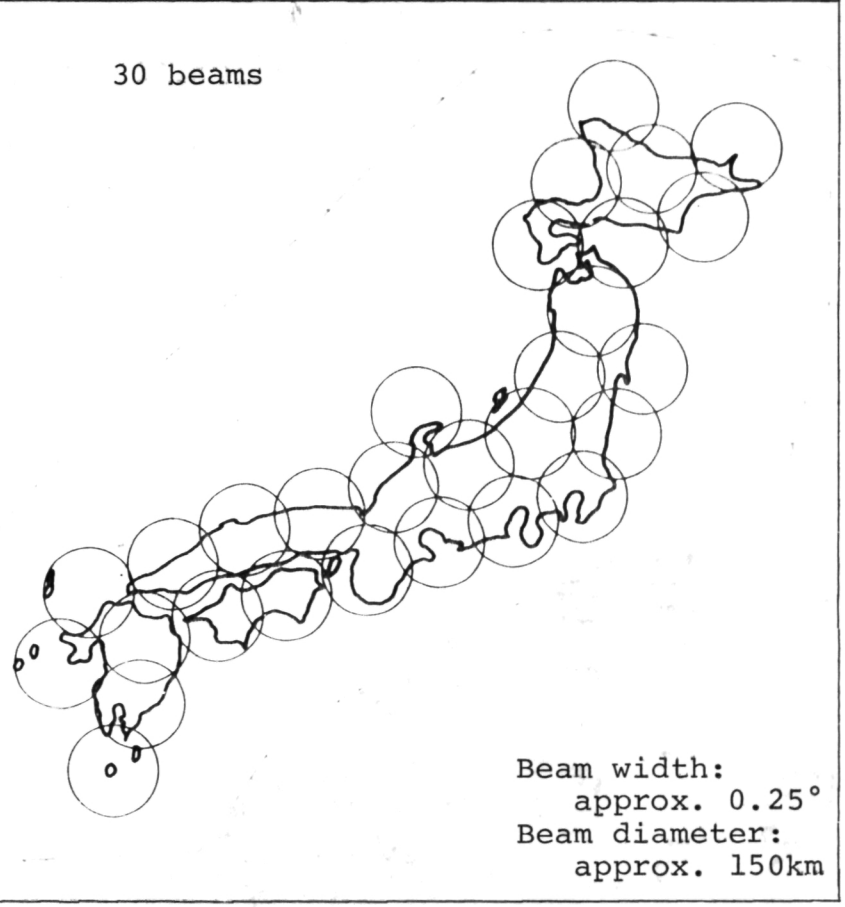
Technology Content		Sample Multibeam Layout
Satellite repeater	TDMA equipment for multibeam communication Satellite switch for inter-beam connection Subscriber exchange equipment for satellite Reproduction repeater for satellite Adoption of LSI, MIC, and high output for satellite repeater	
Satellite antenna	Multibeam antenna Technique for unfolding antenna Technique for highly accurate directional control of antenna	
Bus	Large bus technique (Mounting method, lightweight materials, high efficiency battery, etc.)	

[5] MULTIBEAM SATELLITE COMMUNICATIONS METHOD (2) /28

—TDMA equipment for multibeam communications—

—Satellite repeater for multibeam communications— (breadboard model)

—Functional experiments of the multibeam satellite communications method—

The TDMA equipment for multibeam communications and the satellite repeater (breadboard model) were produced on a trial basis as the first stage of research on the multibeam satellite communications method. The basic functions of both devices were verified. Moreover, a 30/20GHz band satellite circuit was connected vis the CS to these devices and functional experiments are being carried out.

Through these experiments, problems that should be solved are being selected in order to perfect the method and verify the basic techniques in the multibeam satellite communications method.

The technical results obtained from these experiments will be used as a basis to produce the multibeam satellite communications method, and detailed examination is scheduled to proceed from this point.

[5]-1 TDMA EQUIPMENT FOR MULTIBEAM COMMUNICATIONS /29

This TDMA equipment is for multibeam communications and will be installed at the earth station. Trial equipment was produced for the master station and the slave station. This equipment has the following features:

1. It can transmit 200 Mb/s high-speed signals.
2. It can be connected to the land digital synchronization

network.

3. Frame synchronization control method that is stable and can withstand falling rain attenuation of the 30/20GHz band electrical waves.

MAIN PARAMETERS

Item			Parameters
TDMA Control Part	Bit rate (clock		204.8Mb/s (102.4MHz)
	TDMA frame cycle		2ms
	Frame synchronization	master station	Detection of satellite switch timing
		slave station	Detection of synchronizing burst signal from master station
	Circuit assignment		Pre-assign mode
	Land network interface		6.312Mb/s (digital secondary group
Modulator	Modulating/demodulating method		4-phase phase-modulation, synchronization detection
	Middle frequency		1.7GHz

FUNCTIONS OF TDMA EQUIPMENT FOR MULTIBEAM COMMUNICATIONS /30

Time division multiple access (TDMA) is a method whereby the assignment of the satellite circuit to the earth station is divided in strict accordance with time. Therefore, the signals have been sped up so that they can be transmitted from each of the earth stations within the short time allotted, and an intermittent signal that has been compressed relative to time is transmitted. This intermittent signal is called the burst. TDMA equipment that is used in the conventional single beam method and that is located at the master station (a designated earth station) controls the

burst timing from each earth station so that they do not collide at the satellite.

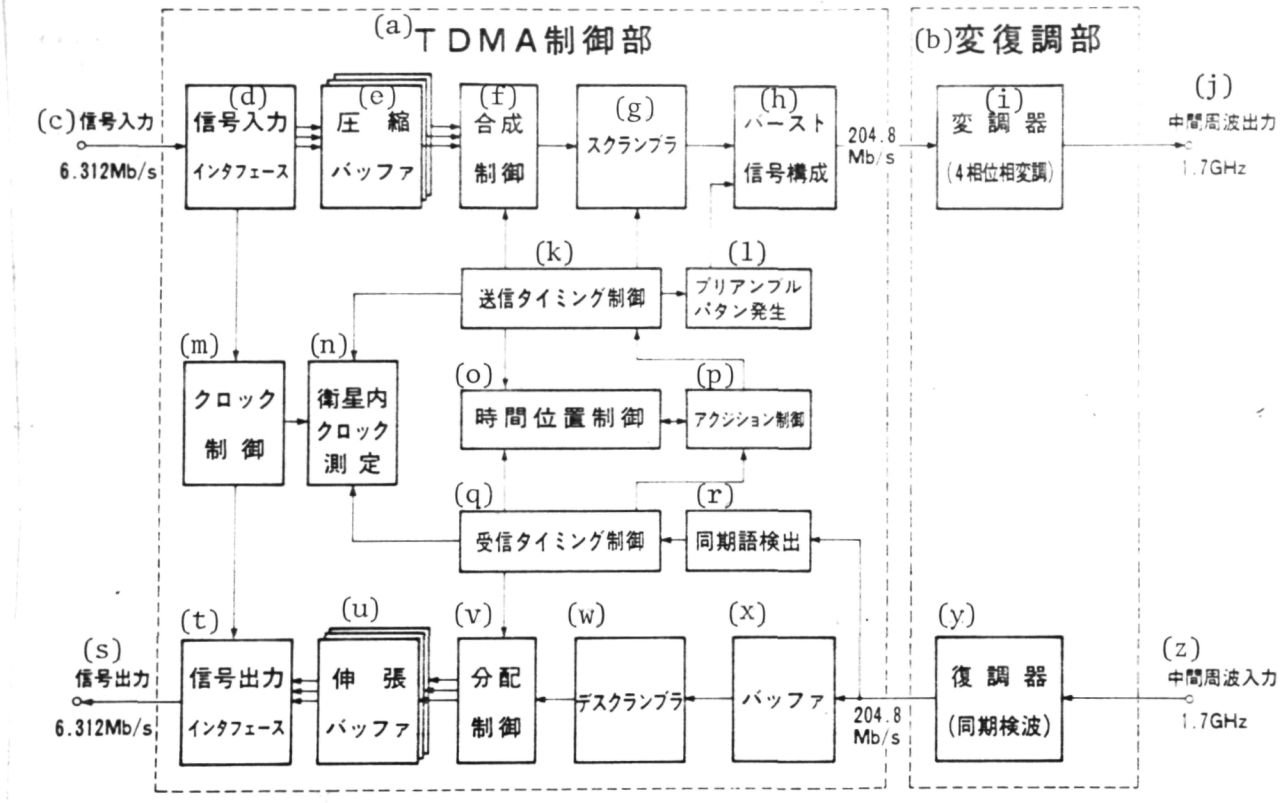
In the multibeam satellite communications method, it is necessary to switch over the beam at the satellite in order to carry out communication between different beams. Therefore, the TDMA equipment for multibeam communication is insufficient with only the function mentioned above; it is necessary for the master station common to all beams to further divide the time assigned to each of the earth stations and to correctly control the bursts from each station so that they do not collide at the satellite and so that they can be connected to the intended beam.

Since the TDMA equipment for multibeam communications is used in conjunction with a satellite switch (a switch on the satellite) to comprise the multibeam satellite communications method, it is also called SS-TDMA equipment.

TDMA: Time Division Multiple Access

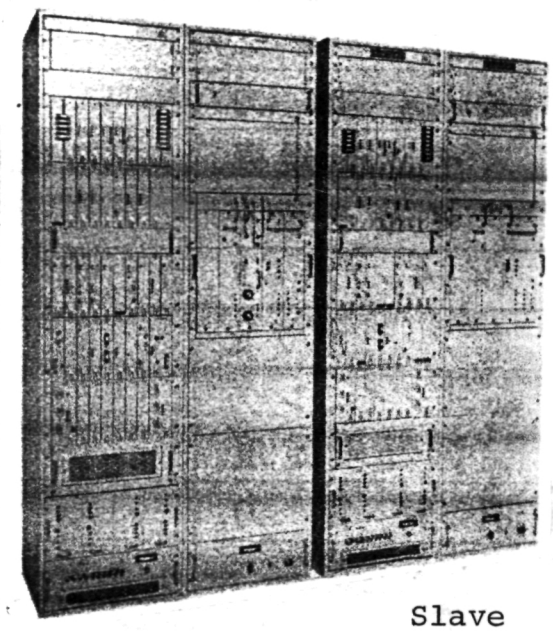
SS-TDMA: Satellite Switched - TDMA

COMPOSITION OF TDMA EQUIPMENT FOR MULTIBEAM COMMUNICATIONS /31



Key:
(a) TDMA control portion
(b) Modem portion
(c) Signal input
(d) Signal input interface
(e) Compression buffer
(f) Synthesis control
(g) Scrambler
(h) Burst signal composition
(i) Modulator (4-phase phase modulation)
(j) Medium frequency output
(k) Transmit timing control
(l) Preamble pattern generation
(m) Clock control
(n) Measurement of clock within satellite
(o) Time position control
(p) Acquisition control
(q) Receive timing control
(r) Synchronous word detection
(s) Signal output
(t) Signal output interface
(u) Expansion buffer
(v) Allocation control
(w) Descrambler
(x) Buffer
(y) Demodulator (Synchronous detection)
(z) Medium frequency output

DMA EQUIPMENT FOR MULTIBEAM COMMUNICATIONS



Slave station

Master station

[5]-2 SATELLITE REPEATER FOR MULTIBEAM COMMUNICATIONS (BREADBOARD MODEL) /32

This is the breadboard model of a newly developed 30/20GHz band satellite repeater for the multibeam communications method. It has the satellite switch for interbeam correction. The features of this repeater are as follows.

1. Satellite switch which uses the low energy consumption GaAsFET.

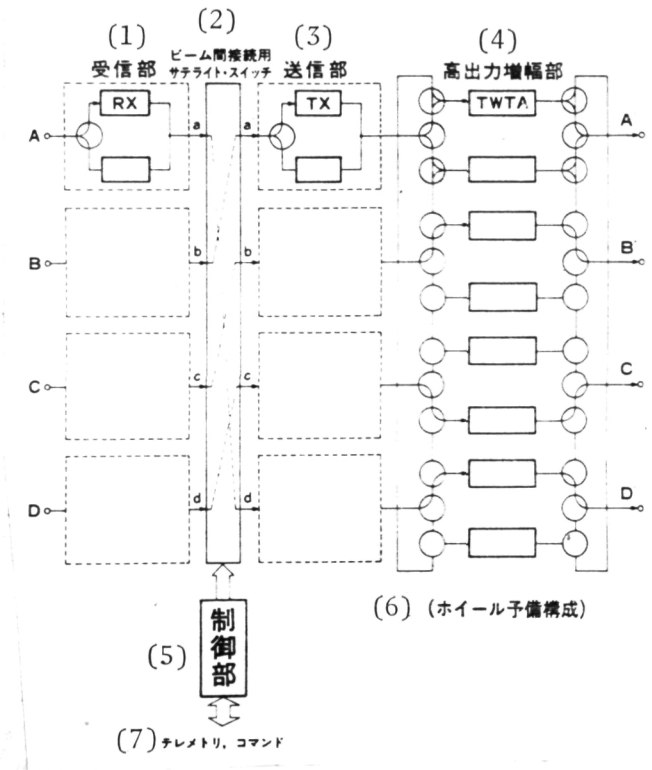
2. The new preparatory structure method (fail preparation) has been used to increase reliability.

MAIN PARAMETERS

Item		Performance
Receiver	Receive frequencies	30GHz band
	Noise index	less than 8dB
	Intermediate frequency	1.8GHz band
Transmitter High-output amplifier	Transmit frequencies	20GHz band
	Transmit output	10W
Satellite switch for inter-beam connection	Switch plan	4 x 4 (foil preparation composition)
	Switch element	GaAsFET
	Switch speed	Rising, less than 80ns Lowering, less than 40ns
	On/off ratio	Greater than 54dB
	Standard timing Oscillator stability	$\pm 1 \times 10^{-9}$/day (-10°C∿+40°C)
	Power consumption	1.5W

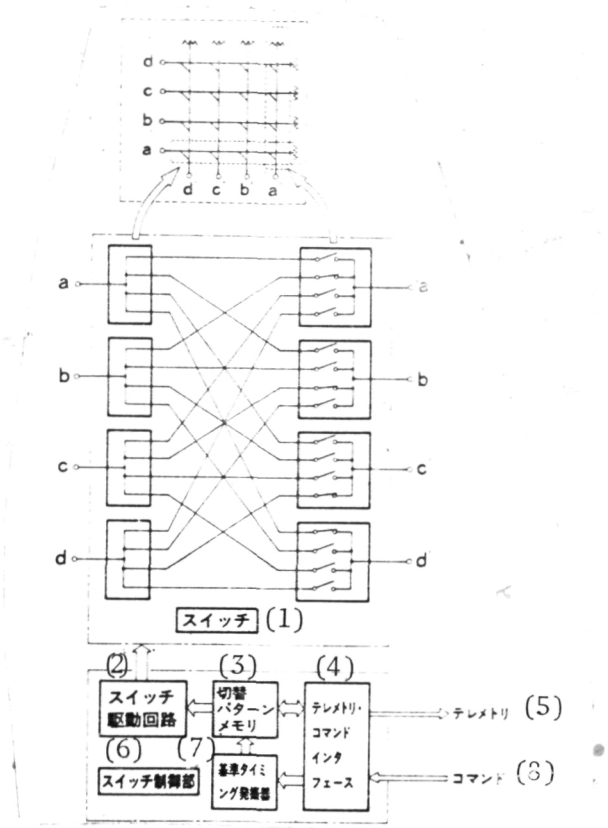
COMPOSITION OF SATELLITE REPEATER FOR MULTIBEAM COMMUNICATIONS (BREADBOARD MODEL)

/33



Key: (1) Receiver
(2) Satellite switch for inter-beam connection
(3) Transmitter
(4) High-output amplifier
(5) Controller
(6) (Foil preparation composition)
(7) Telemetry, command

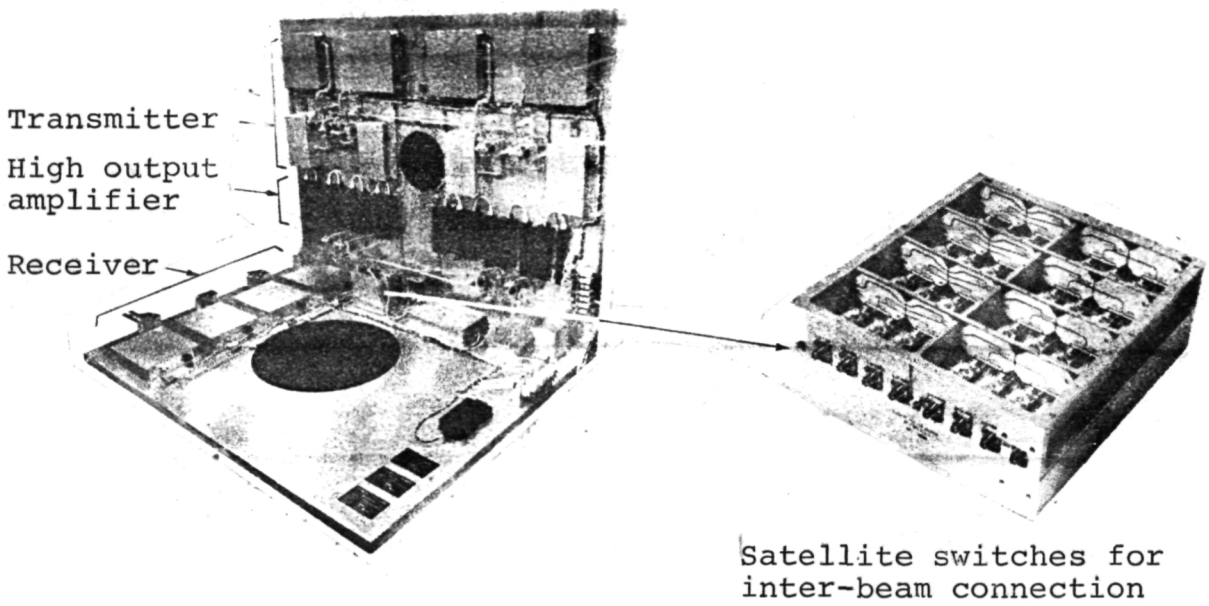
COMPOSITION OF SATELLITE SWITCH FOR INTER-BEAM CONNECTION



(The actual equipment will have a foil preparation in order to improve reliability.)

Key:
(1) Switch
(2) Switch drive circuit
(3) Switchoner pattern memory
(4) Telemetry command interface
(5) Telemetry
(6) Switch controller
(7) Standard timing oscillator
(8) Command

SATELLITE REPEATER FOR MULTIBEAM COMMUNICATIONS
(BREADBOARD MODEL)



5-3 FUNCTIONAL EXPERIMENTS FOR THE MULTIBEAM SATELLITE COMMUNICATIONS METHOD

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The TDMA equipment for multibeam communications and the satellite repeater (breadboard model) were connected with a satellite circuit via the "Sakura," an experimental, intermediate-capacity, stationary communications satellite; and the first functional experiment in the world for the 30/20GHz band was a success. In this way, the basic technology needed to bring about the 4-beam method was established.

(Contents of Experiment)

1. Confirmation of synchronization establishment function

2. Confirmation of connecting function to the land digital synchronizing network.

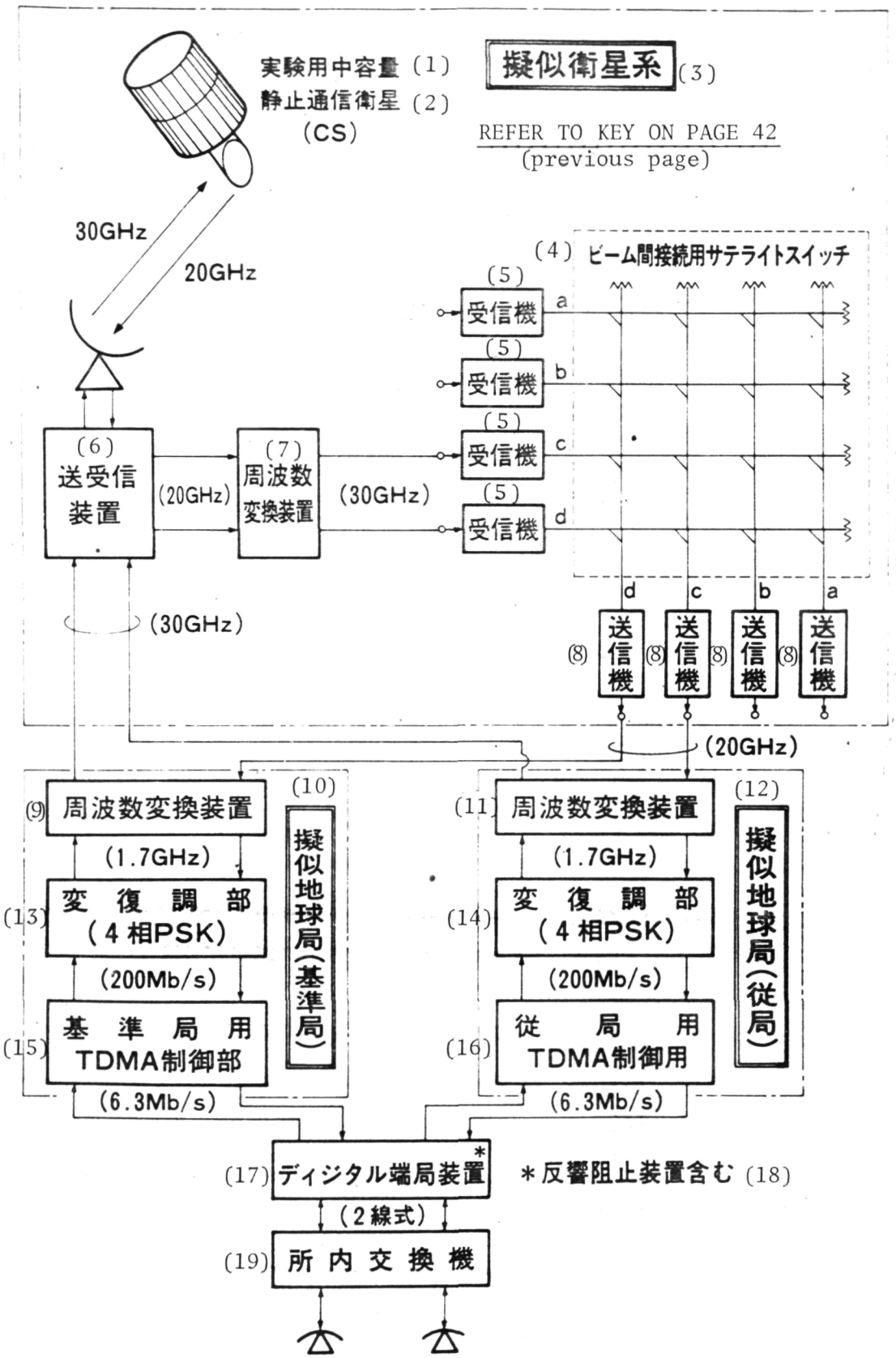
3. Confirmation of switchover characteristics of the satellite switch.

The technology obtained from this experiment will serve as a basis for further research regarding this method.

COMPOSITION OF FUNCTIONAL EXPERIMENT CIRCUIT FOR THE MULTIBEAM SATELLITE COMMUNICATIONS METHOD /35

(See diagram on Page 43)

Key:
(1) Experimental medium capacity
(2) Stationary communications satellite (CS)
(3) Pseudo satellite system
(4) Satellite switches for inter-beam connection
(5) Receivers
(6) Transmit/receive equipment
(7) Frequency conversion equipment
(8) Transmitters
(9) Frequency conversion equipment
(10) Pseudo earth station (master station)
(11) Frequency conversion equipment
(12) Pseudo earth station (slave station)
(13) Modulator/demodulator (4-phase PSK)
(14) Modulator/demodulator (4-phase PSK)
(15) TDMA control for master station
(16) TDMA control for slave station
(17) Digital equipment at terminal station
(18) *Including echo prevention equipment
(19) Exchange equipment


実験用中容量 (1)
静止通信衛星 (2)
(CS)
擬似衛星系 (3)
REFER TO KEY ON PAGE 42
(previous page)
30GHz
20GHz
(4) ビーム間接続用サテライトスイッチ
(5) 受信機 a
(5) 受信機 b
(5) 受信機 c
(5) 受信機 d
(6) 送受信装置
(20GHz)
(7) 周波数変換装置
(30GHz)
(30GHz)
d c b a
(8) 送信機 (8) 送信機 (8) 送信機 (8) 送信機
(20GHz)
(9) 周波数変換装置
(1.7GHz)
(13) 変復調部 (4相PSK)
(200Mb/s)
(15) 基準局用 TDMA制御部
(6.3Mb/s)
(10) 擬似地球局(基準局)
(11) 周波数変換装置
(1.7GHz)
(14) 変復調部 (4相PSK)
(200Mb/s)
(16) 従局用 TDMA制御用
(6.3Mb/s)
(12) 擬似地球局(従局)
(17) ディジタル端局装置*
(2線式)
(19) 所内交換機
*反響阻止装置含む (18)

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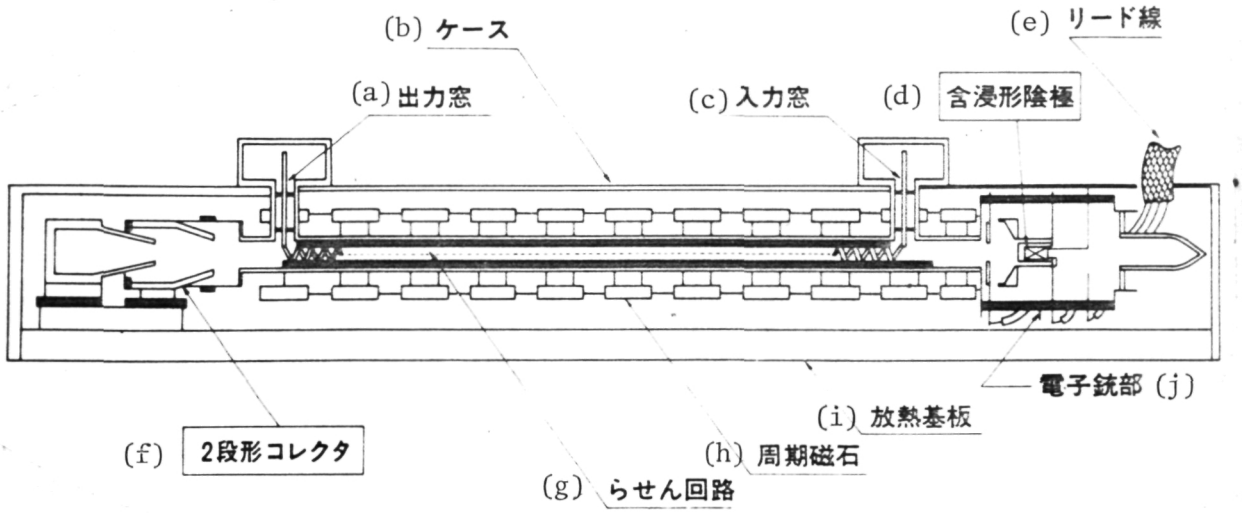
COMPOSITION OF 20GHZ BAND 10W SATELLITE
TRAVELLING WAVE TUBE AMPLIFIER

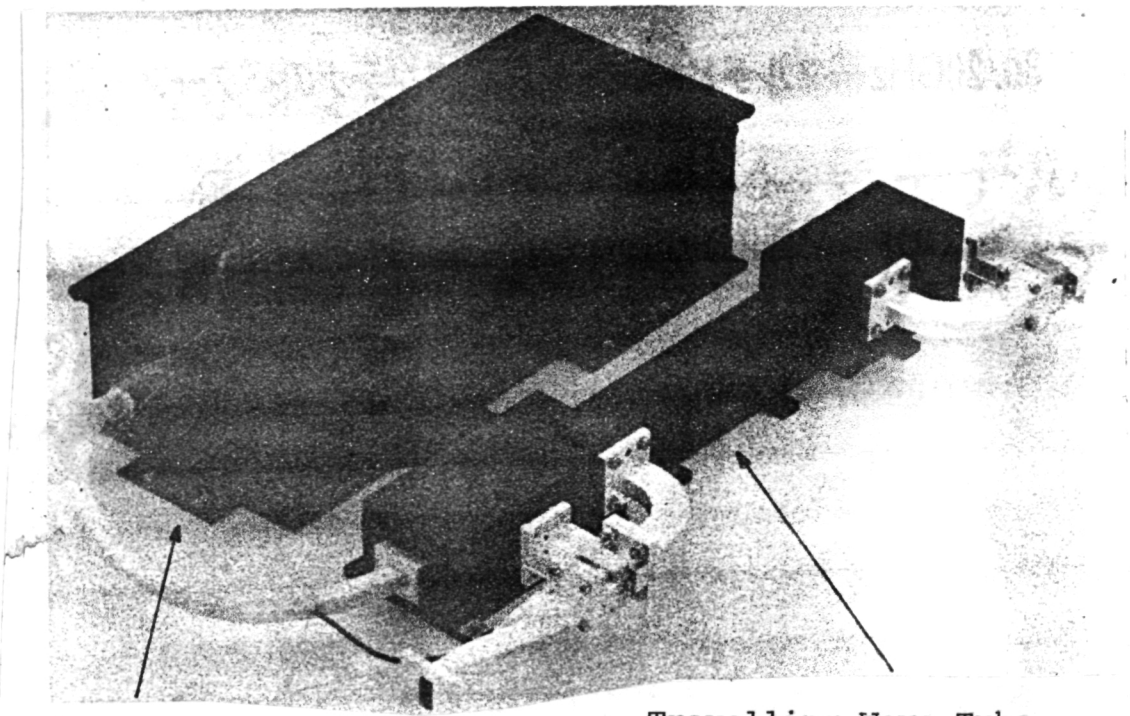
/37



Ceramic (the spiral circuit is beryllia and other parts are alumina-ceramic)

Key:
(a) Output window
(b) Case
(c) Input window
(d) Impregnated cathode
(e) Lead
(f) 2-stage collector
(g) Sprial circuit
(h) Cyclic magnet
(i) Heat-radiating base plate
(j) Electron gun

20GHZ BAND 10W SATELLITE TRAVELLING
WAVE TUBE AMPLIFIER



Power
supply

Travelling Wave Tube
Amplifier

7 MULTIBEAM SATELLITE COMMUNICATIONS METHOD (4) /38

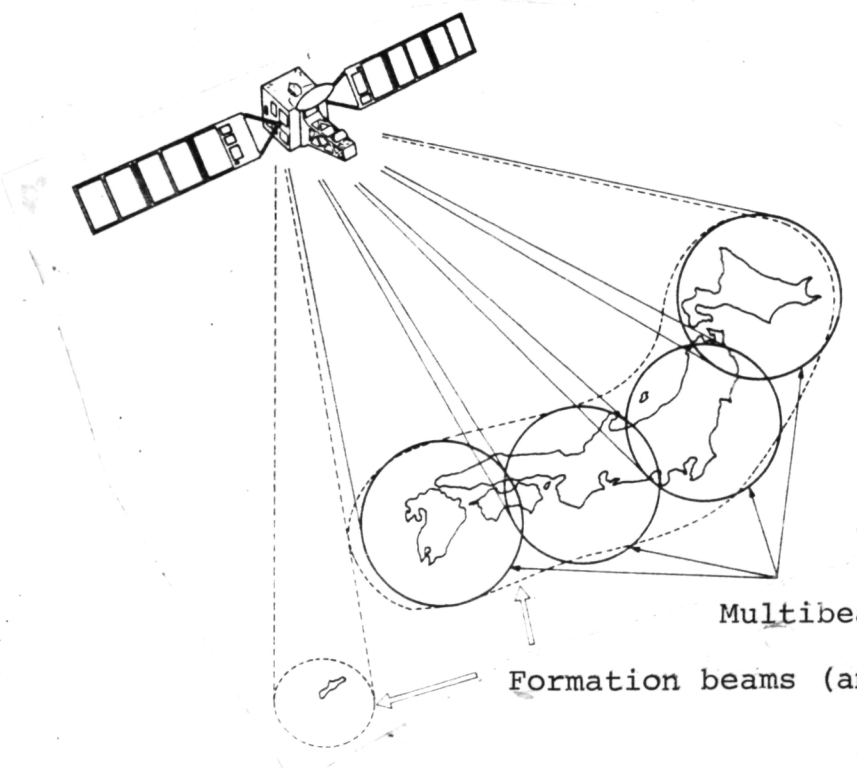
—30/20GHz Band Multibeam Satellite Antenna (Electric model)—

This antenna was developed for the multibeam satellite communications method which covers the mainland of Japan with four beams.

The technique was developed whereby the primary radiation devices, with small-diameter openings, could be placed closely together; and more than a 39dB antenna gain and sufficient communication performance (USWR, ellipitcal base wave rate) could be achieved for the first time in the world for the 30/20 GHz band.

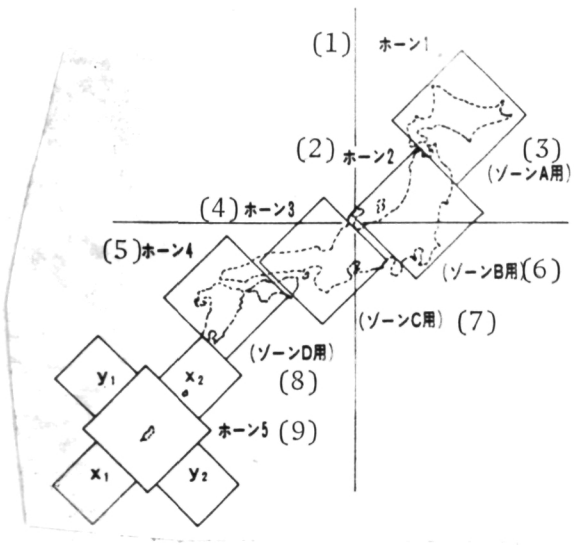
Along with having a mono pulse sensor for high accuracy directional control, this method features formation beams that match the shape of Japan and that can radiate simultaneously.

30/20 GHZ BAND MULTIBEAM SATELLITE
ANTENNA PATTERN



POWER SUPPLY SYSTEM OF MULTIBEAM ANTENNA

/39



Hone Distribution

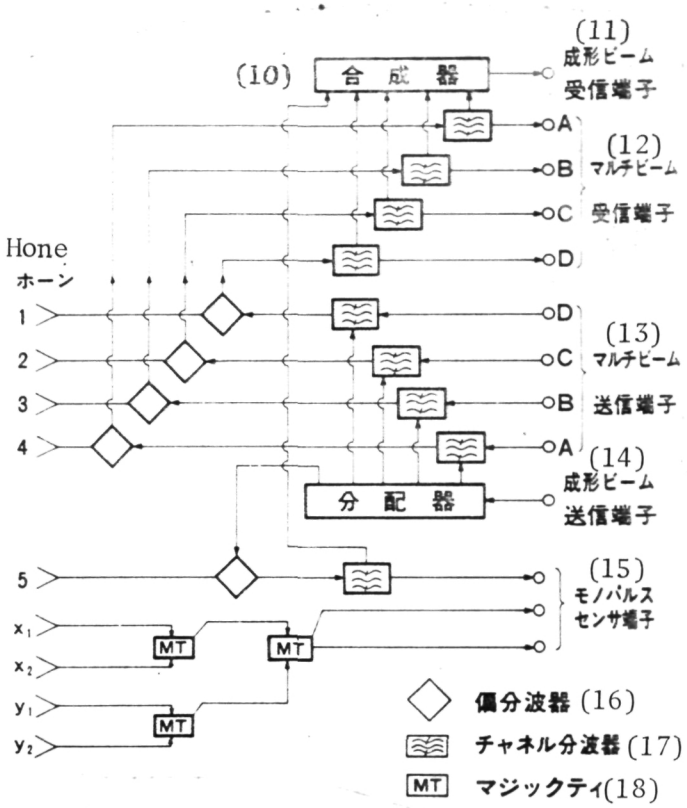
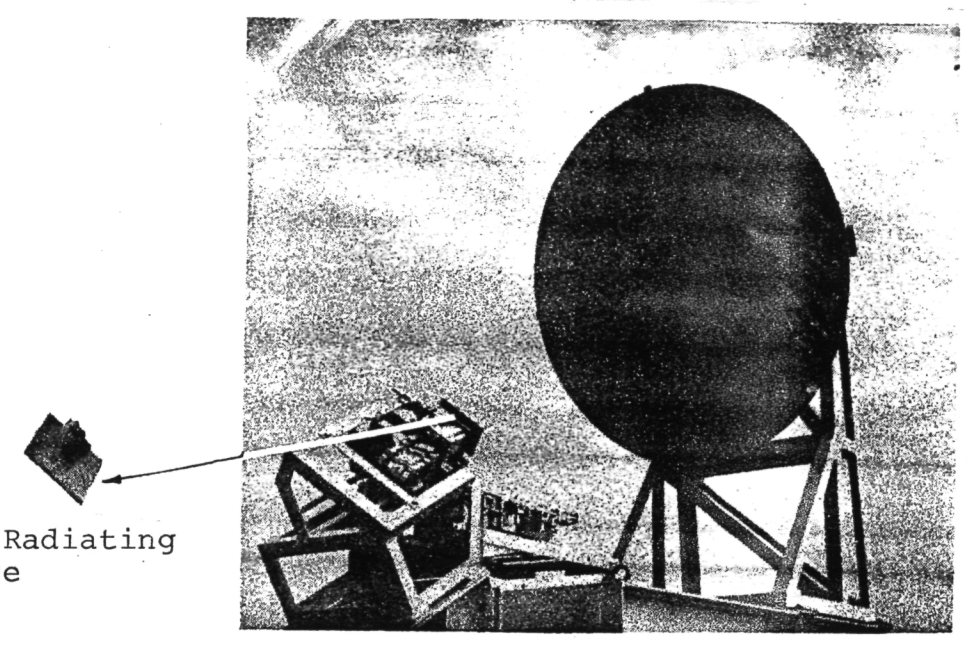


Diagram of Power Supply System

Key:
(1) Hone 1
(2) Hone 2
(3) (for zone A)
(4) Hone 3
(5) Hone 4
(6) (for zone B)
(7) (for zone C)
(8) (for zone D)
(9) Hone 5
(10) Synthesizer
(11) Formation beam receive terminals
(12) Multibeam receive terminals
(13) Multibeam send terminals
(14) Formation beam send terminals
(15) Monopulse sensor terminal
(16) Bias branching filter
(17) Channel branching filter
(18) Magic T

30/20GHZ BAND MULTIBEAM SATELLITE ANTENNA
(ELECTRIC MODEL)



Primary Radiating
Device